LONG RANGE SEISMIC MEASUREMENTS

CHASE IV
(SANTIAGO IGLESIAS)

16 SEPTEMBER 1965

Prepared for

AIR FORCE TECHNICAL APPLICATIONS CENTER

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By

UED EARTH SCIENCES DIVISION
TELEDYNE, INC.

Under

Project VELA UNIFORM

Sponsored By

ADVANCED RESEARCH PROJECTS AGENCY
Nuclear Test Detection Office
ARPA Order No. 624

LONG RANGE SEISMIC MEASUREMENTS

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SEISMIC DATA LABORATORY REPORT NO. 137

AFTAC Project No.:	VELA T/2037
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AVAILABILITY

Distribution of this document is unlimited

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CHASE IV

EVENT DESCRIPTION

DATE: 16 September 1965

TIME OF ORIGIN: 19:51:10.2Z

YIELD: 300 Tons TNT Equivalent

MAGNITUDE: 4.73 ± 0.39

LOCATION:

SITE: Off the Coast of Maryland in the Atlantic Ocean

Geographic Coordinates:

Lat: 37°11'34" N

Long: 74°26'34" W

ENVIRONMENT:

Geologic Medium: Salt Water

Depth of Water: ≈ 5100 ft.

Depth of Shot: ≈ 900 ft.

COMPUTED EPICENTER:

Geographic Coordinates:

Lat: 37°17'17" N

Long: 74°38'53" W

Time of Origin: 19:51:13.3Z

Depth: 14 km

Epicenter Shift: 41 km, N 75° W

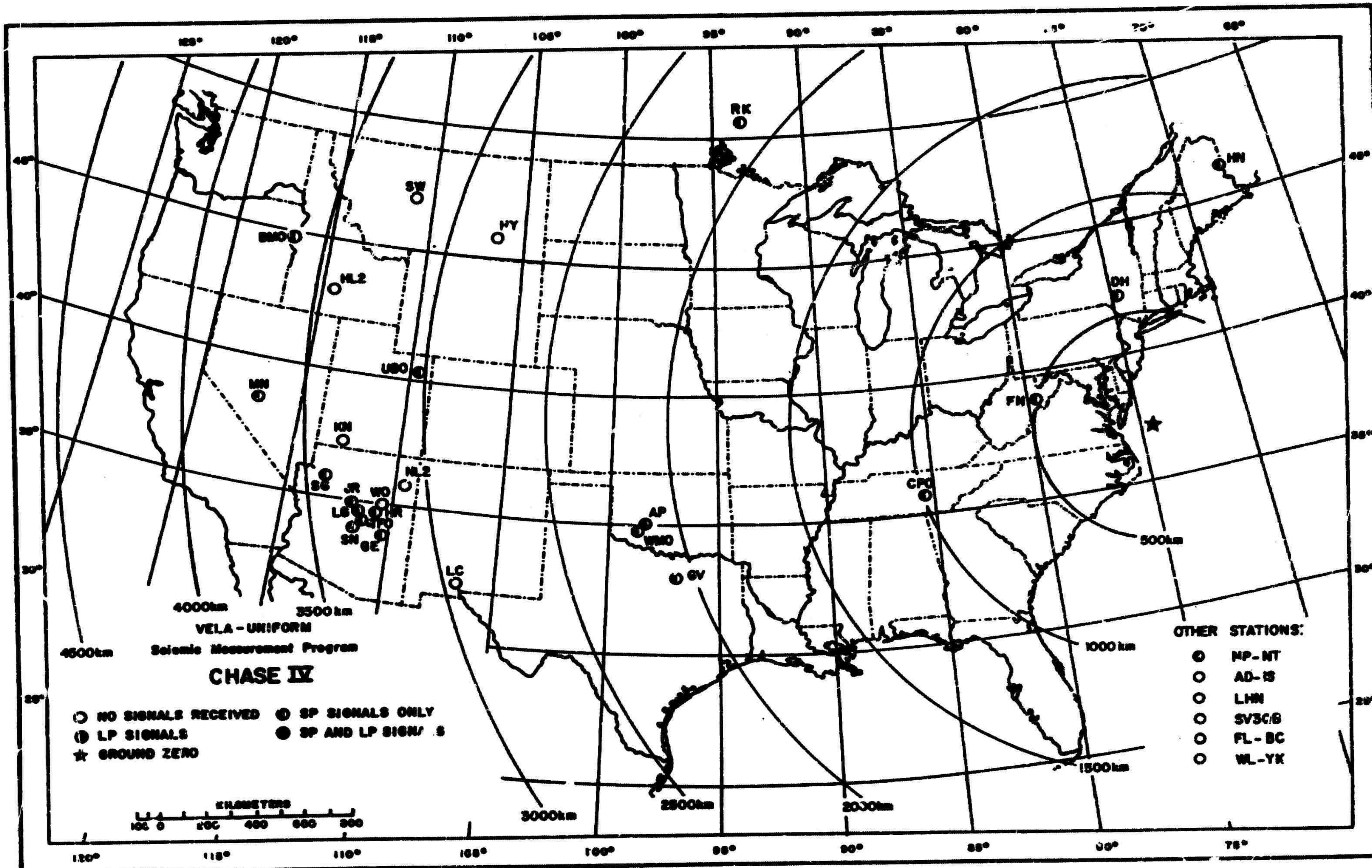
Code	Station	Final SPZ	SPR	SPT	LPZ	LPR	LPT	Tape	Timing
FN-WV	Franklin, West Virginia	+	+	+	N	N	N		P
DH-NY	Delhi, New York	+	+	+	-	-	-	*	P
CPSO	Cumberland Plateau Observatory, Tennessee	+	+	+	-	-	-	*	P
HN-ME	Houlton, Maine	+	+	+	-	-	-	*	P
SV-QB	Schefferville, Quebec, Canada	I	I	I	I	I	I		
GV-TX	Grapevine, Texas	+	+	+	-	N	N		P
RK-ON	Red Lake, Ontario, Canada	+	+	+	-	-	-	*	P
AP-OK	Apache, Oklahoma	+	N	N	N	N	N		P
WMSO	Wichita Mountain Observatory, Oklahoma	+	+	+	-	-	-	*	P
HY-MA	Hysham, Montana	CORRECT FILM NOT RECEIVED							
LC-NM	Las Cruces, New Mexico	MOVING							
UBSO	Uinta Basin Observatory, Utah	+	+	+	-	-	-	*	P
NL2AZ	Naslini, Arizona	-	-	-	-	-	-	*	P
WO-AZ	Winslow, Arizona	L	L	L	-	-	-	*	P
HR-AZ	Heber, Arizona	L	+	L	-	-	-	*	P
GE-AZ	Globe, Arizona	L	+	L	-	-	-	*	P
SW-MA	Sweetgrass, Montana	MOVING							
TFSO	Tonto Forest Observatory, Arizona	+	+	+	-	-	-	*	P
LG-AZ	Long Valley, Arizona	+	+	+	-	-	-	*	P
JR-AZ	Jerome, Arizona	+	+	+	-	-	-	*	P
SN-AZ	Sunflower, Arizona	L	+	L	-	-	-	*	P
KN-UT	Kanab, Utah	-	-	-	-	-	-	*	P
HL2ID	Hailey, Idaho	SETTING UP							
SG-AZ	Seligman, Arizona	+	+	+	-	-	I	*	P
BMSO	Blue Mountain Observatory, Oregon	+	+	+	-	-	-	*	P
MN-NV	Mina, Nevada	+	+	+	-	-	-	*	P
FL-BC	Fort Nelson, British Columbia	SETTING UP							
WL-YK	Watson Lake, Yukon	SETTING UP							
MP-NT	Mould Bay, Northwest Territories, Canada	+	+	+	-	-	-	*	P
LHN	Lillehammer, Oslo, Norway	-	-	-	-	-	-	*	P
AD-IS	Adak Island, Alaska	-	-	-	-	-	-	*	P

I Inoperative
L Signal Obscured by Local Event
N No Instrument
P Primary Timing

\+ Signal
\- No Signal
* Magnetic Tape Available

Station Status Report - CHASE IV

Table 1



Recording Stations and Signals Received

Figure 1

Introduction

A long range seismic measurements (LRSM) program was established under VELA-UNIFORM to record and analyze short-period and long-period data from a planned series of U.S. underground nuclear tests. These, and other data, will be used by VELA-UNIFORM participants for studying and developing methods for distinguishing between explosive and earthquake sources.

CHASE IV was an explosion of surplus ammunition of approximately 300 tons of TNT equivalent, which was authorized and conducted by the Office of Naval Research (ONR). The explosives were loaded into an expendable Liberty ship (Santiago Iglesias). The ship was sunk and the explosives detonated at a prearranged depth.

The purpose of this report is to provide an analysis of data resulting from the CHASE IV event from the LRSM film seismograms from operating mobile field teams; Wichita Mountain Observatory, Oklahoma (WMSO), Uinta Basin Observatory, Utah (UBSO), Blue Mountain Observatory, Oregon (BMSO), Cumberland Plateau Observatory, Tennessee (CPSO), and Tonto Forest Observatory, Arizona (TFSO); and from several experimental or temporary stations operated in connection with

other research programs.

<u>Instrumentation and Procedure</u>

Instrumentation at each of the mobile stations consists of three-component short-period Benioff and three-component Sprengnether long-period seismographs. Data are recorded on 35 millimeter film and on one-inch 14-channel magnetic tape. All of these stations are equipped to record WWV continuously in order to provide accurate time control. Calibration is accomplished once each day and just prior to each shot at operating settings. Specific details of the instrumentation and operating procedures for these stations are given in <u>Field Manual, Long Range Seismic Measurement Program</u>, Technical Report No. 63-17, which can be obtained from the Geotech Division of Teledyne Industries, Inc., Dallas, Texas. All the observatories have both long-period and short-period, three-component instrumentation, in addition to their other specialized facilities.

Station site information is presented in Appendix I(A). This includes the station name and code; the geographic coordinates, distances and azimuths involved; the station elevations; and the type of instruments in use at each location.

A status report for CHASE IV is included in Table 1, placed opposite the operations map, Figure 1. This report gives the names of 31 stations and indicates which instruments were operational and which recorded signals.

An explanation of the procedure for amplitude measurements used in this report is illustrated in Appendix II. The unified magnitude (m) computations for distances less than 16° are based on AFTAC/VSC extensions of Gutenberg's Tables*. For this purpose, points from 10° to 16° were read from a curve in the Gutenberg-Richter paper and an inverse cube relationship was used to extrapolate from two to ten degrees. A table of the distance factors (B) is provided in Appendix I(B).

A standard hypocenter location program for a digital computer has been used to determine the location using data from all stations analyzed. Best-fit values of latitude, longitude, depth of focus, and time of origin are determined statistically by a least squares technique. This utilizes a Jeffreys-Bullen travel-time curve as modified by Herrin in 1961 on the basis of Pacific surface-focus recordings. Pre-

*Gutenberg, B. and Richter, C. F., Magnitude and Energy of Earthquakes, Ann. Geofis., 9 (1956), pp. 1-15.

cision of the computation is limited primarily by the accuracy of arrival times, the validity of the standard travel-time curve, and by local velocity deviations. Since the method is based on P wave arrivals, this particular program does not make use of later phases such as pP and S in the determination of depth or location. Results are shown on the Event Description page.

Data and Results

Table 2 summarizes the measurements made of the principal phases from the CHASE IV event. Included are the Pn and P arrival times, the maximum amplitudes (A/T) of Pn or P and Pg motion as seen on the short-period vertical instruments, and the maximum amplitudes (A/T) of the Lg phase as measured on the short-period horizontal tangential component. Nineteen stations recorded usable short-period signals. Two other stations probably recorded CHASE IV, but an overriding local event obscured the signals. Long-period signals from this event were not recorded.

In addition, Table 2 and Figure 2 show the unified magnitudes (m) where measurable. The average magnitude for CHASE IV is 4.73 ± 0.39 .

The travel-time residuals from the Pn and P phase are within the usual limits (see Figure 3). The amplitudes of Pn and P, Pg and Lg are shown in Figures 4, 5 and 6. Lines proportional to the inverse cube of the distance visually fitted through the observed points are shown on these graphs.

Attached to the report are illustrative seismograms showing the signals recorded at a number of locations. The most distant station analyzed that recorded CHASE IV was NP-NT at a distance of 4890 kilometers.

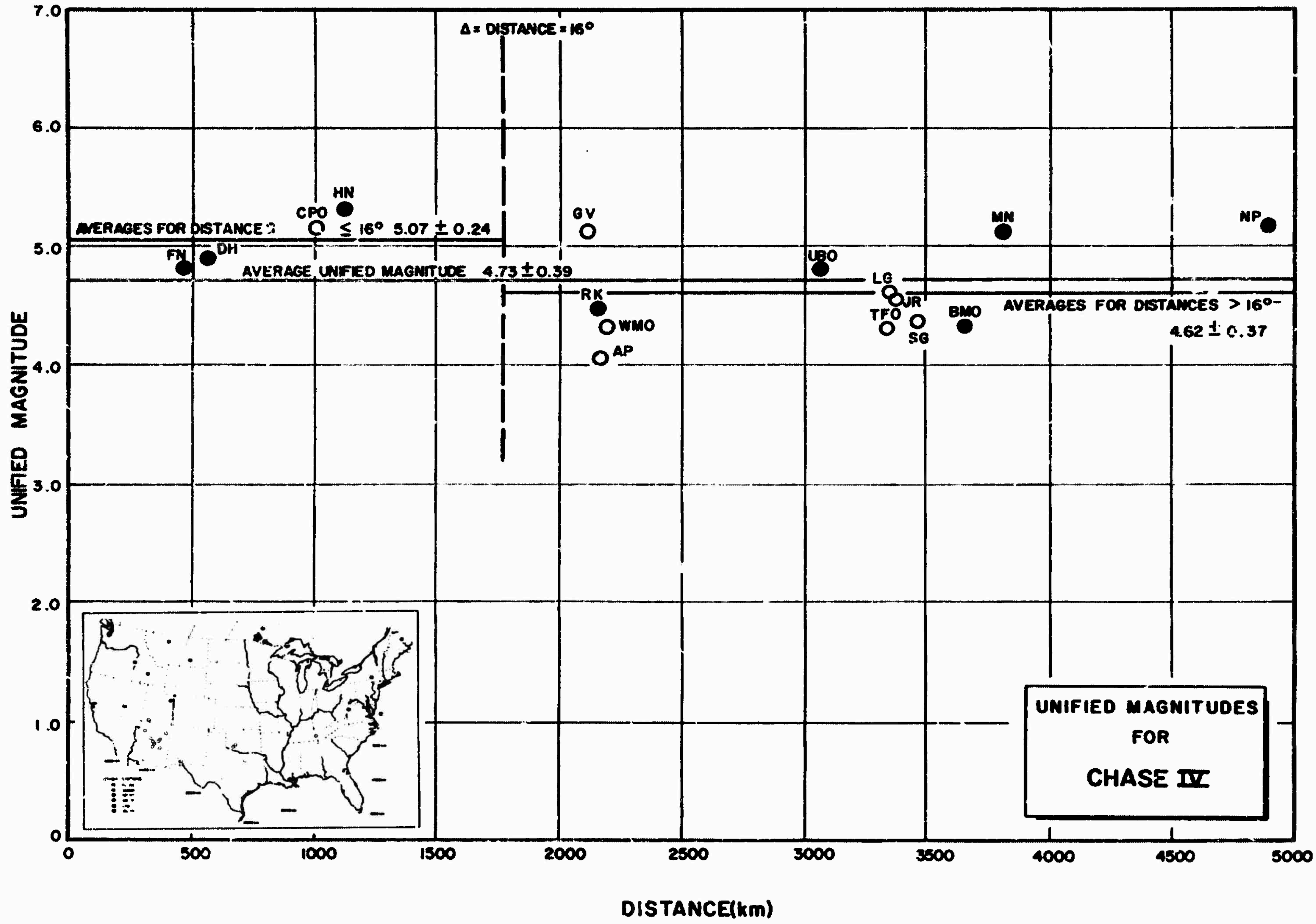
Principal Phases
CHASE IV
18 September 1965
19:51:19.?

Code	Station	Distance (km)	Inst.	Magnification (K) Film x10	Phase	Observed Travel Time (min)	Observed Travel Time (sec)	Period T (sec)	Maximum Amplitude A/T	Magnitude (m)
FM-WV	Franklin, West Virginia	471	SPZ	32.8	Pn	01	02.7	0.6	46.9	6.04
			SPZ	32.8	e	01	10.4	9.6	118.0	
			SPZ	32.8	Pg	01	33.2	0.8	671.8	
			SPT	52.8	Lg			8.9	1261.0	
DH-NY	Delhi, New York	562	SPZ	23.2	Pn	01	(18.8)	8.9	32.2	6.92
			SPZ	22.2	e	01	25.8	0.6	77.0	
			SPZ	23.2	e	01	29.0	0.6	105.0	
			SPZ	22.2	(Pg)	01	34.0	3.9	623.0	
			SPT	75.6*	Lg			1.0	231.0	
CPSO	Cumberland Plateau Observatory, Tennessee	1012	SPZ-9	540.0	Pn	02	12.6	0.7	8.9	2.16
			SPZ-BL	25.0	e	02	22.0	0.7	162.0	
			SPZ-BL	22.0	e	02	36.3	0.7	144.0	
			SPZ-BL	22.0	Pg	02	38.8	0.7	86.2	
			SPZ-BL	25.0	e	03	50.1	0.9	67.3	
			SPZ-BL	23.0	e	05	55.4	0.8	90.1	
			SPR		Lg			---	---	
HN-ME	Houlton, Maine	1151	SPZ	120.0	Pn	02	(27.2)	0.6	11.4	2.34
			SPZ	120.0	e	02	29.9	0.8	14.2	
			SPZ	120.0	e	02	40.6	8.7	21.4	
			SPZ	120.0	e	02	50.5	0.8	32.2	
			SPZ	120.0	e	02	52.2	0.8	27.0	
			SPZ	120.0	e	02	59.7	0.6	(28.2)	
			SPZ	120.0	(Pg)	03	16.7	0.7	27.2	
			SPR	121.0	Lg			1.0	227.0	
GV-TX	Grapevine, Texas	2107	SPZ	25.73	P	04	(32.0)	(1.0)	(136.0)	(2.15)
			SPR	23.73	e	04	15.0	0.8	114.0	
			SPR	32.6	Lg			(0.9)	(68.1)	
RK-ON	Red Lake, Ontario, Canada	2151	SPZ	193.0	P	04	(26.0)	1.2	38.7	6.58
			SPZ	145.0	e	04	36.9	1.0	24.4	
			SPZ	195.0	e	04	38.1	0.8	26.9	
			SPZ	195.0	e	04	47.1	0.6	17.5	
			SPZ	165.8	(PcP)	09	01.5	1.0	30.9	
			SPZ	274.0	Lg			1.1	136.0	
AP-OK	Apache, Oklahoma	2173	SPR	480.0	P	04	(30.9)	(0.9)	(11.2)	(6.05)
					e	06	62.5	9.9	21.5	
WMSO	Wichita Mountain Observatory, Oklahoma	2190	SPZ-6	210.8	P	04	30.9	1.0	21.6	6.23
			SPZ-6	210.9	e	04	36.8	1.0	40.9	
			SPZ-6	210.9	e	04	42.2	1.2	66.9	
			SPZ-6	210.3	(PP)	04	48.7	0.9	26.0	
			SPZ-4	210.0	e	04	52.4	1.0	26.4	
			SPZ-6	210.0	e	05	04.2	1.2	39.5	
			SPZ-6	210.0	e	05	18.6	1.2	30.2	
			SPZ-6	210.0	e	05	30.9	1.2	16.1	
			SPZ-6	210.0	e	04	07.1	1.0	11.9	
			SPZ-6	210.0	e	06	48.0	0.9	11.1	
			SPZ-6	210.0	PcP	08	59.3	1.2	20.1	
			SPN		Lg			---	---	
UBSO	Uinta Basin Observatory, Utah	3054	SPZ-10	570.0	P	02	46.4	1.1	19.7	6.84
			SPZ-10	570.0	e	06	08.7	0.9	9.2	
			SPZ-10	570.0	e	04	21.9	(1.1)	(29.9)	
			SPZ-10	970.0	e	04	52.6	(1.6)	(26.8)	
			SPZ-10	570.0	e	07	09.2	1.1	.1.9	
			SPZ-10	270.9	e	07	57.9	1.0	8.2	
			SPZ-10	270.0	e	08	19.8	1.1	12.1	
			SPZ-10	570.0	PcP	09	06.0	1.1	11.0	
			SPZ-10	570.0	e	09	40.0	1.2	7.4	
			SPN		Lg			---	- -	
WO-AZ	Winslow, Arizona	3251	LOCAL EVENT INTERFERED WITH SIGNAL							
HB-AZ	Heber, Arizona	3270	"P" PHASE OBSCURED BY LOCAL EVENT							
			SPN	350.0	Lg			1.2	26.6	
GE-AZ	Globe, Arizona	3277	"P" PHASE OBSCURED BY LOCAL EVENT							
			SPN	637.5	Lg			1.2	7.9	
TFSO	Tonto Forest Observatory, Arizona	3324	SPZ-1	870.0	P	06	11.7	0.9	9.2	4.32
			SPZ-1	970.0	e	06	91.9	(0.7)	(6.2)	
			SPZ-1	970.0	e	07	18.5	1.1	3.1	
			SPZ-1	870.0	e	07	39.0	1.6	5.1	
			SPZ-2	870.0	e	08	04.1	1.0	2.7	
			SPZ-1	870.0	PcP	09	16.6	1.0	5.4	
			SPZ-1	870.0	e	09	37.1	1.5	6.9	
			SPZ-1	870.0	e	11	03.4	1.2	2.5	
			SPN	862.0	Lg			1.5	12.7	
LV-AZ	Long Valley, Arizona	3367	SPZ	239.0	P	06	(12.9)	1.9	(19.2)	(6.65)
			SPN	250.9	Lg			1.1	17.4	
JR-AZ	Jerome, Arizona	3376	SPZ	247.0	P	04	(15.4)	0.6	9.0	6.50
			SPN	224.0	Lg			1.5	42.4	
SN-AZ	Sunflower, Arizona	3377	"P" PHASE OBSCURED BY LOCAL EVENT							
			SPN	380.0	Lg			1.2	12.2	
SG-AZ	Seligman, Arizona	3642	SPZ	705.9	P	04	22.9	0.8	2.00	4.29
			SPZ	705.9	e	04	25.8	1.0	9.2	
			SPZ	705.9	e	06	34.2	1.1	10.0	
			SPZ	705.9	e	06	61.0	1.0	2.3	
			SPZ	703.0	e	07	(32.0)	1.1	6.2	
			SPZ	705.0	PcP	09	18.2	(0.8)	(5.0)	
			SPZ	705.0	e	09	28.0	1.5	7.5	
			SPN	612.?	Lg			1.6	22.0	
BMSO	Blue Mountain Observatory, Oregon	3621	SPZ-3	750.0	P	06	34.7	1.0	4.2	4.35
			SPZ-3	750.0	e	06	43.1	0.9	2.9	
			SPZ-5	750.0	e	06	67.9	1.8	6.0	
			SPZ-5	750.0	e	06	54.8	1.9	5.7	
			SPZ-5	750.0	e	07	06.3	8.4	2.9	
			SPZ-5	750.0	e	07	12.9	1.1	3.2	
			SPZ-3	750.0	e	07	36.2	0.9	5.8	
			SPZ-3	750.0	PcP	09	22.5	9.8	2.?	
			SPN	750.0	Lg			1.6	2.2	
MN-NV	Mina, Nevada	3819	SPZ	612.9	P	06	50.1	1.2	26.1	?.12
			SPZ	612.9	e	06	23.8	1.2	21.1	
			SPZ	612.9	e	06	59.4	1.2	19.7	
			SPZ	612.9	e	07	06.8	1.2	9.8	
			SPZ	612.0	e	07	13.1	1.2	12.8	
			SPZ	612.0	e	07	24.6	1.2	14.9	
			SPZ	612.0	e	07	36.2	1.1	2.7	
			SPZ	612.0	PP	08	02.6	1.6	7.1	
			SPZ	612.0	PcP	09	24.9	1.0	4.1	
			SPT	554.0	Lg			0.7	2.2	
MB-NW	Mould Bay, Northwest Territories, Canada	4890	SPZ	180.8	P	08	10.0	1.2	67.7	6.19
			SPZ	180.6	e	08	19.9	1.2	30.9	
			SPZ	183.9	e	08	36.4	1.4	17.9	
			SPZ	180.0	PP	09	54.0	1.2	38.2	

A/T mμ/sec
( ) Doubtful Values or Phases
* Measurements Made from Playouts
e Phases Reported but not Identified
--- Clipped on Film and Tape

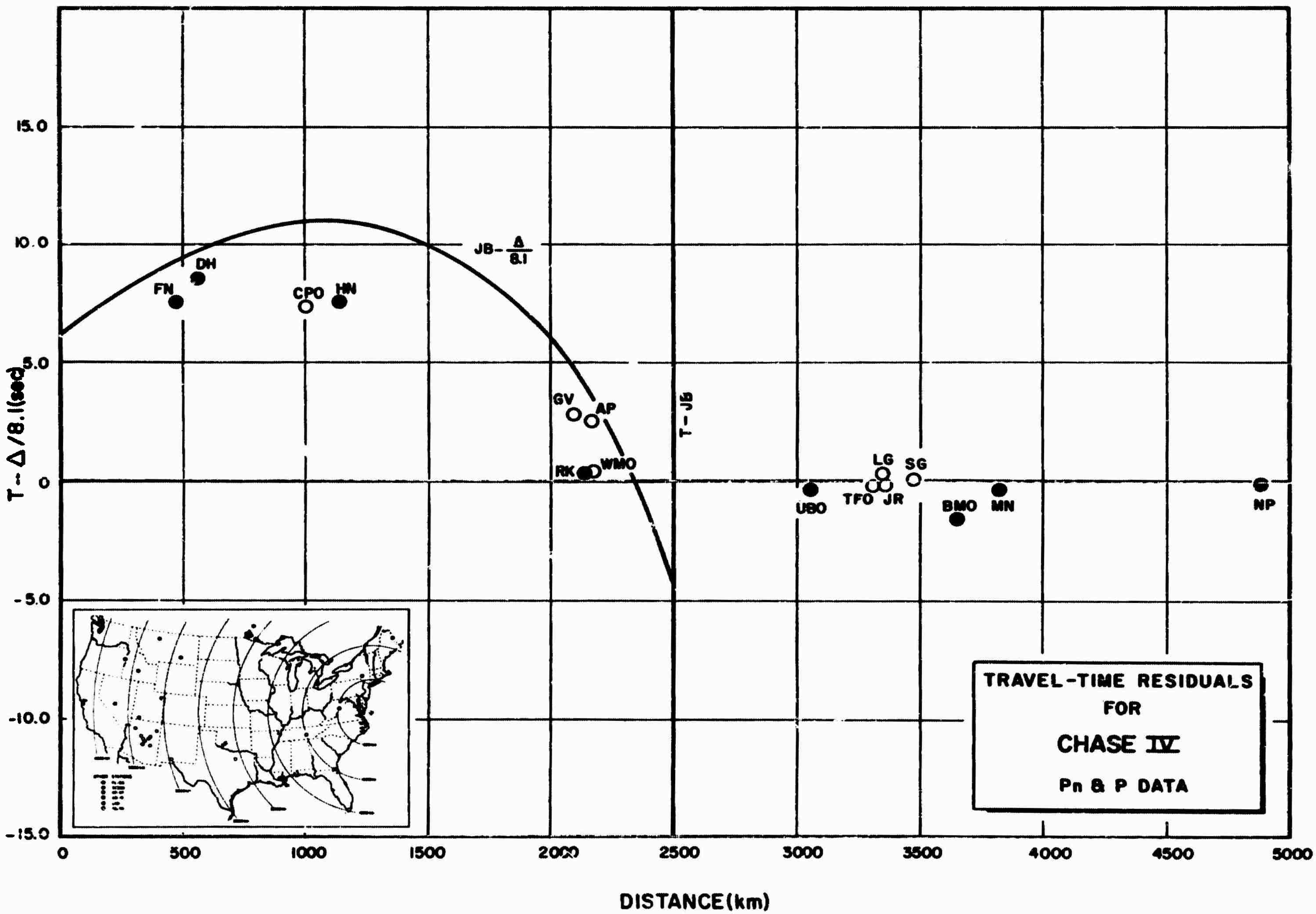
Principal Phases - CHASE IV

Table 2



7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
UNIFIED MAGNITUDE
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
DISTANCE(km)
Δ = DISTANCE = 16°
AVERAGES FOR DISTANCES ≤ 16° 5.07 ± 0.24
AVERAGE UNIFIED MAGNITUDE 4.73 ± 0.39
AVERAGES FOR DISTANCES > 16°
4.62 ± 0.37
FN
DH
CPO
HN
GV
RK
WMO
AP
UBO
LG
UR
TFO
SG
BMO
MN
NP
UNIFIED MAGNITUDES
FOR
CHASE IV

Figure 2



TRAVEL-TIME RESIDUALS
FOR
CHASE IV
Pn & P DATA
$JB-\frac{\Delta}{8.1}$
T - JB
FN
DH
CPO
HN
GV
AP
RK
WMO
UBO
TFO
LG
JR
SG
BMO
MN
NP
$T-\Delta/8.1$(sec)
DISTANCE(km)
15.0
10.0
5.0
0
-5.0
-10.0
-15.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000

Figure 3

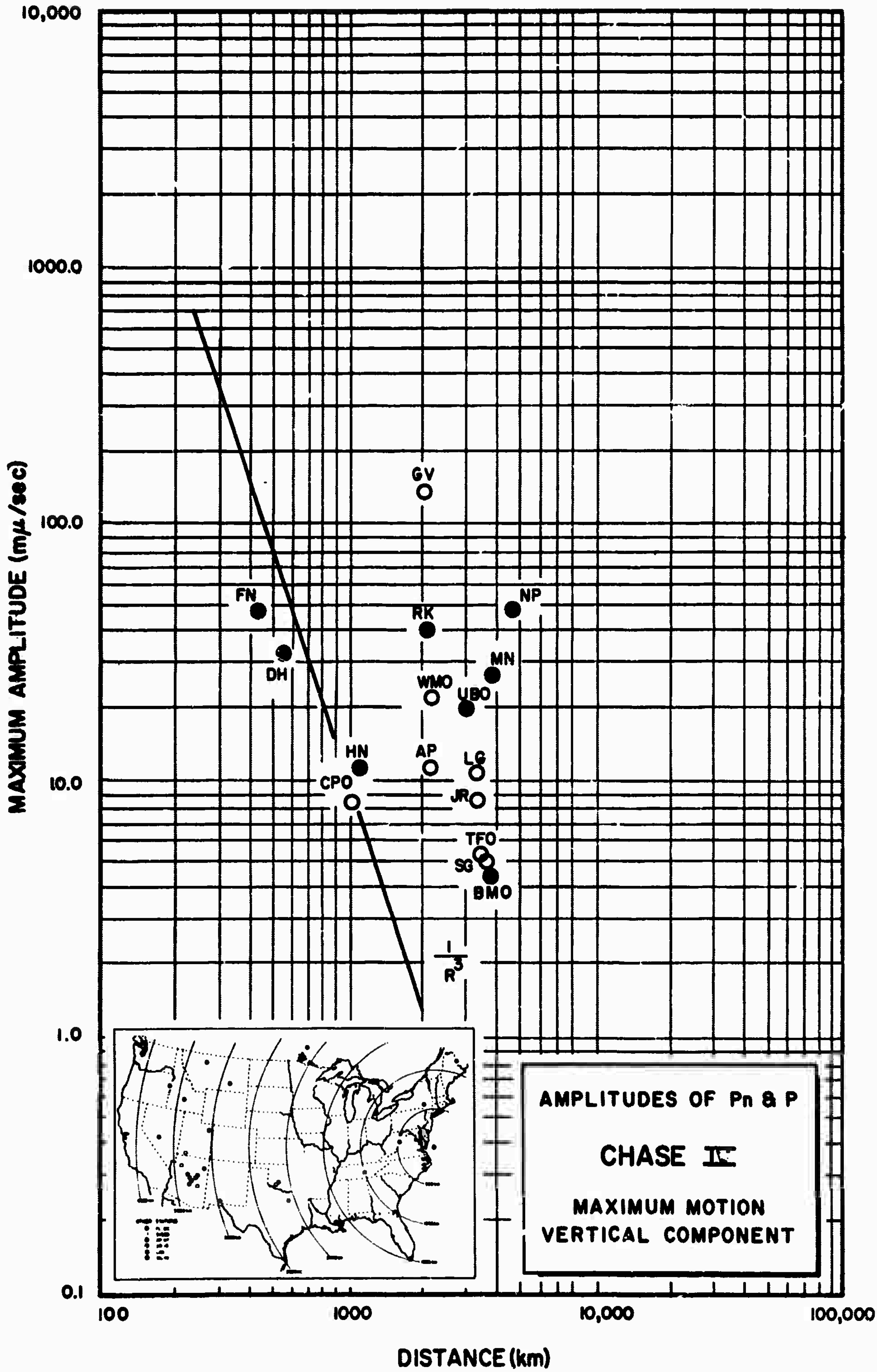
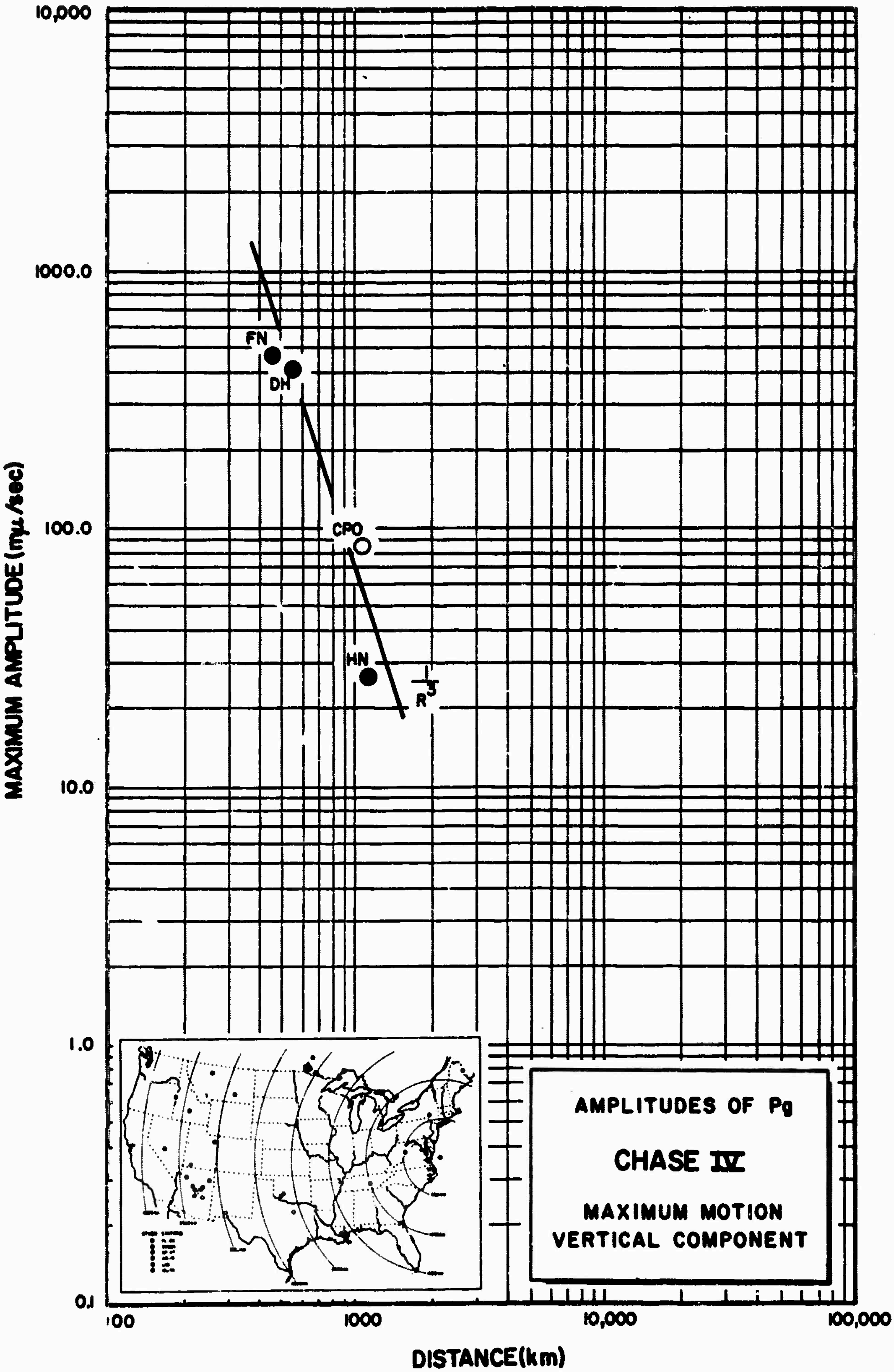
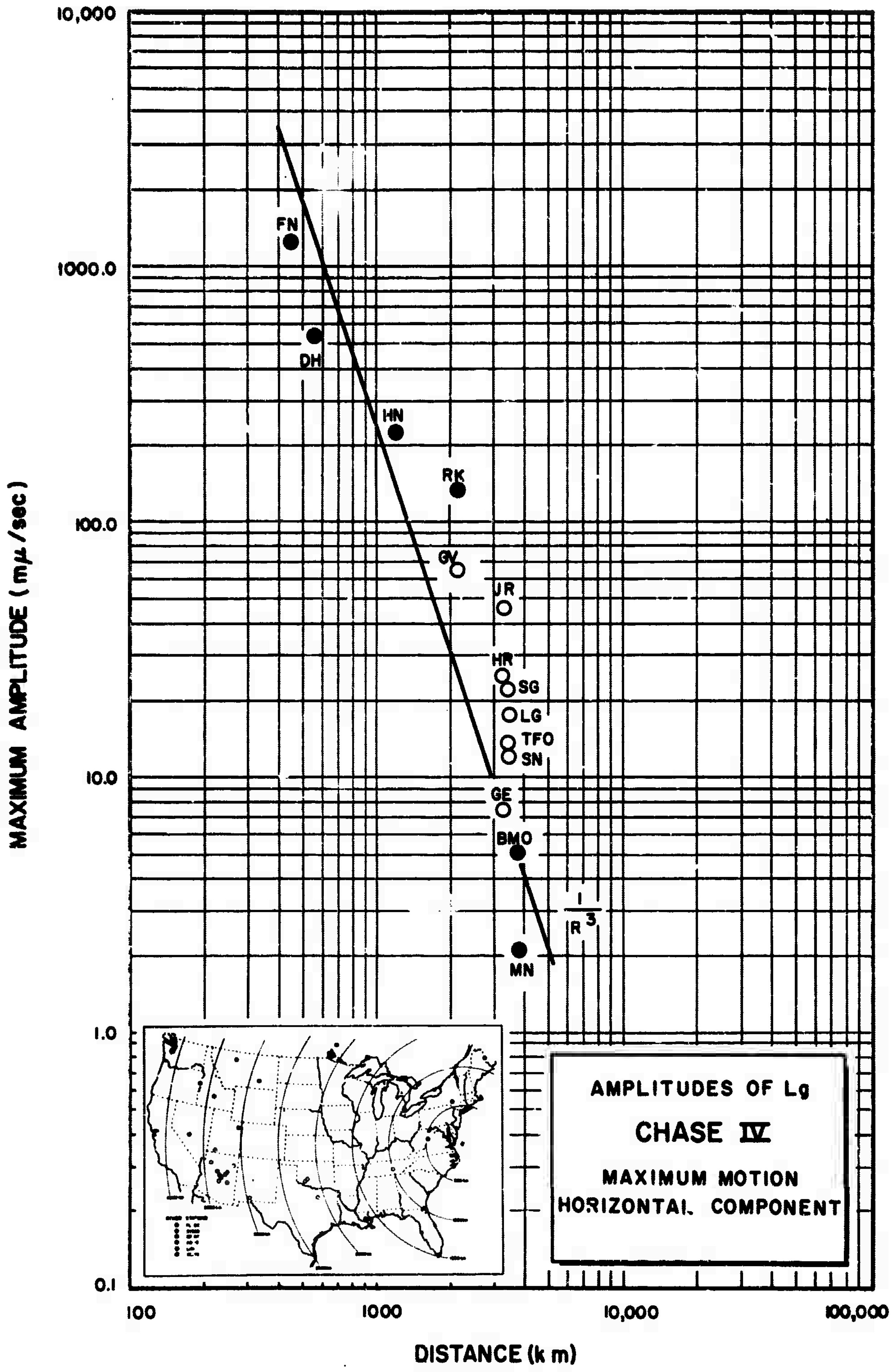

10,000
1000.0
100.0
10.0
1.0
0.1
MAXIMUM AMPLITUDE (mμ/sec)
100
1000
10,000
100,000
DISTANCE (km)
GV
FN
DH
RK
NP
MN
WMO
UBO
HN
AP
LG
CPO
JR
TFO
SG
BMO
$\frac{1}{R^3}$
AMPLITUDES OF Pn & P
CHASE IV
MAXIMUM MOTION
VERTICAL COMPONENT

Figure 4



10,000
1000.0
100.0
10.0
1.0
0.1
MAXIMUM AMPLITUDE (mμ/sec)
100
1000
10,000
100,000
DISTANCE (km)
FN
DH
CPO
HN
$\frac{1}{R^3}$
AMPLITUDES OF Pg
CHASE IV
MAXIMUM MOTION
VERTICAL COMPONENT

Figure 5



10,000
1000.0
100.0
10.0
1.0
0.1
MAXIMUM AMPLITUDE (mμ/sec)
100
1000
10,000
100,000
DISTANCE (k m)
FN
DH
HN
RK
GV
JR
HR
SG
LG
TFO
SN
GE
BMO
MN
1/R3
AMPLITUDES OF Lg
CHASE IV
MAXIMUM MOTION
HORIZONTAL COMPONENT

Figure 6

Code	Station	Distance (km)	Geographic Latitude	Geographic Longitude	Elev. (km)	Computed Azimuth		Installed Azimuth		Large or Small SP	LP Inst.
						Epi. Sta.	Sta. Epi.	Radial	Tang.		
FN-WV	Franklin, West Virginia	471	38°32'58" N	79°30'47" W	0.91	290°	107°	99°	189°	S	-
DH-NY	Dalhi, New York	562	42°14'39" N	74°53'18" W	0.65	356°	176°	95°	185°	S	X
CPSO-Z8	Cumberland Plateau Observatory, Tennessee	1013	35°35'41" N	85°34'13" W	0.57	263°	77°	90°	0°	JM	X
HN-ME	Houlton, Maine	1131	46°09'43" N	67°59'09" W	0.21	26°	211°	93°	183°	S	X
SV-QB	Schefferville, Quebec, Canada	2045	54°48'39" N	66°45'00" W	0.59	14°	200°	139°	229°	S	X
GV-TX	Grapevine, Texas	2107	32°53'09" N	96°59'54" W	0.15	264°	71°	111°	201°	L	LPZ
RK-ON	Red Lake, Ontario, Canada	2151	50°50'20" N	93°40'20" W	0.37	321°	127°	58°	148°	S	X
AP-OK	Apache, Oklahoma	2173	34°49'59" N	98°26'09" W	0.43	270°	76°	-	-	S	-
WMSO-Z6	Wichita Mountain Observatory, Oklahoma	2190	34°43'05" N	98°35'21" W	0.51	270°	76°	90°	0°	JM	X
HY-MA	Hysham, Montana	2862	45°58'21" N	107°04'45" W	0.98	300°	98°	41°	131°	-	-
LC-NM	Las Cruces, New Mexico	2976	32°24'08" N	106°35'58" W	1.59	259°	71°	124°	214°	L	X
UBSO-Z10	Uinta Basin Observatory, Utah	3054	40°19'18" N	109°34'07" W	1.60	287°	85°	90°	0°	JM	X
NL2AZ	Nazlini, Arizona	3138	35°48'25" N	109°37'43" W	1.92	278°	77°	131°	221°	L	X
WO-AZ	Winslow, Arizona	3251	34°52'53" N	110°37'15" W	1.59	276°	75°	131°	221°	L	X
HR-AZ	Heber, Arizona	3270	34°40'11" N	110°45'59" W	1.88	276°	74°	131°	221°	L	X
GE-AZ	Globe, Arizona	3277	33°46'32" N	110°31'41" W	1.48	274°	73°	131°	221°	L	X
SW-MA	Sweetgrass, Montana	3283	48°58'08" N	111°57'46" W	1.11	305°	99°	120°	210°	S	X
TFSO-Z1	Tonto Forest Observatory, Arizona	3326	34°17'12" N	111°16'03" W	1.49	276°	74°	90°	0°	JM	X
LG-AZ	Long Valley, Arizona	3347	34°24'28" N	111°32'45" W	1.77	276°	74°	131°	221°	S	X
JR-AZ	Jerome, Arizona	3374	34°49'32" N	111°59'25" W	1.31	277°	74°	131°	221°	L	X
SN-AZ	Sunflower, Arizona	3377	33°51'49" N	111°41'34" W	0.38	275°	73°	131°	221°	L	X
KN-UT	Knab, Utah	3389	37°01'22" N	112°49'39" W	1.74	282°	78°	95°	185°	L	X
HL2ID	Hailey, Idaho	3435	43°33'40" N	114°25'08" W	1.83	295°	88°	124°	214°	L	X
SG-AZ	Seligman, Arizona	3462	35°38'27" N	113°15'39" W	1.68	279°	76°	131°	221°	L	X
BMSO-Z3	Blue Mountain Observatory, Oregon	3661	44°50'56" N	117°18'20" W	1.19	297°	88°	0°	90°	JM	X
MN-NV	Mina, Nevada	3815	38°26'10" N	118°08'53" W	1.52	286°	78°	308°	38°	L	X
FL-BC	Fort Nelson, British Columbia, Canada	4207	58°51'38" N	122°50'11" W	0.66	321°	103°	103°	193°	L	X
WL-YK	Watson Lake, Yukon	4564	60°07'00" N	128°45'52" W	0.72	322°	99°	97°	187°	L	X
MP-NT	Mould Bay, Northwest Territories, Canada	4890	76°15'08" N	119°22'18" W	0.06	346°	126°	356°	86°	JM S	X
LHN	Lillehammer, Norway	6240	61°02'57" N	10°52'48" E	0.51	36°	287°	138°	228°	L	X
AD-IS	Adak Island, Alaska	7611	51°52'30" N	176°40'45" W	0.06	319°	57°	0°	90°	L	X

Recording Site Information - CHASE IV

Appendix I(A)

Unified Magnitude: $m = \log_{10} (A/T)_{,} + B$

where

A = zero to peak ground motion in millimicrons $= \dfrac{(mm)\ (1000)}{K}$

T = signal period in seconds

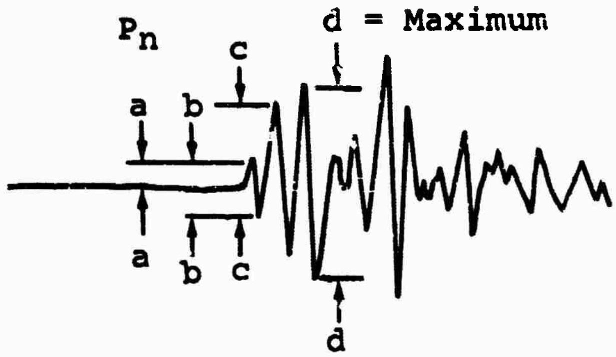
B = distance factor (see Table below)

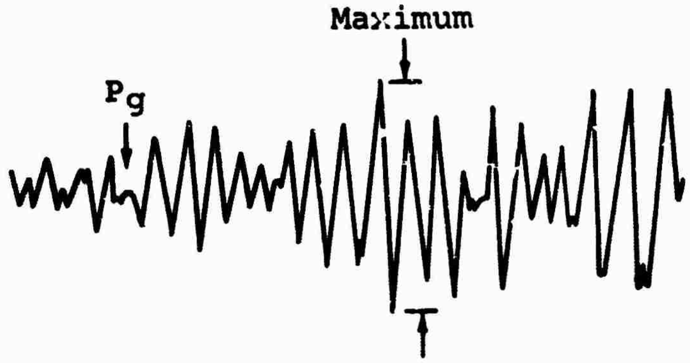
mm = record amplitude in millimeters zero to peak

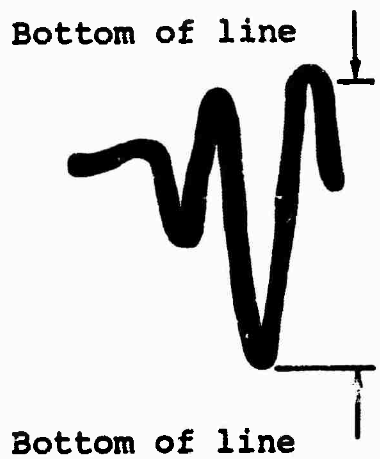
K = magnification in thousands at signal frequency

Table of Distance Factors (B) for Zero Depth

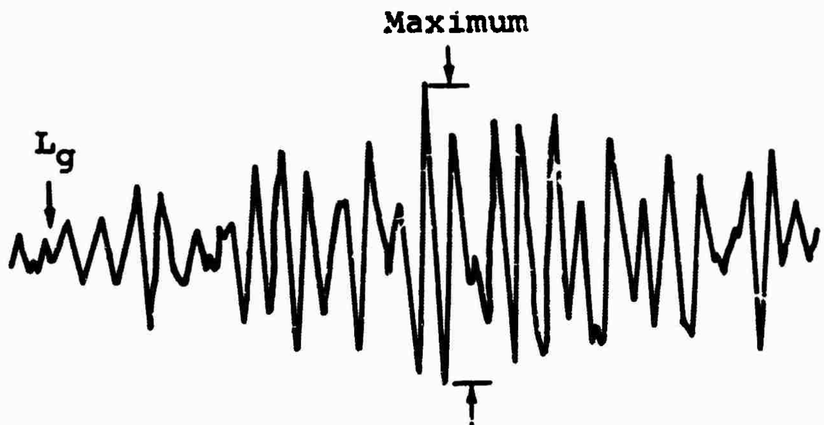
Dist (deg)	B	Dist (deg)	B	Dist (deg)	B	Dist (deg)	B
0°	-	27°	3.5	54°	3.8	80°	3.7
1	-	28	3.6	55	3.8	81	3.8
2	2.2	29	3.6	56	3.8	82	3.9
3	2.7	30	3.6	57	3.8	83	4.0
4	3.1	31	3.7	58	3.8	84	4.0
5	3.4	32	3.7	59	3.8	85	4.0
6	3.6	33	3.7	60	3.8	86	3.9
7	3.8	34	3.7	61	3.9	87	4.0
8	4.0	35	3.7	62	4.0	88	4.1
9	4.2	36	3.6	63	3.9	89	4.0
10	4.3	37	3.5	64	4.0	90	4.0
11	4.2	38	3.5	65	4.0	91	4.1
12	4.1	39	3.4	66	4.0	92	4.1
13	4.0	40	3.4	67	4.0	93	4.2
14	3.6	41	3.5	68	4.0	94	4.1
15	3.3	42	3.5	69	4.0	95	4.2
16	2.9	43	3.5	70	3.9	96	4.3
17	2.9	44	3.5	71	3.9	97	4.4
18	2.9	45	3.7	72	3.9	98	4.5
19	3.0	46	3.8	73	3.9	99	4.5
20	3.0	47	3.9	74	3.8	100	4.4
21	3.1	48	3.9	75	3.8	101	4.3
22	3.2	49	3.8	76	3.9	102	4.4
23	3.3	50	3.7	77	3.9	103	4.5
24	3.3	51	3.7	78	3.9	104	4.6
25	3.5	52	3.7	79	3.8	105	4.7
26	3.4	53	3.7				







Detail Showing Allowance For Line Width



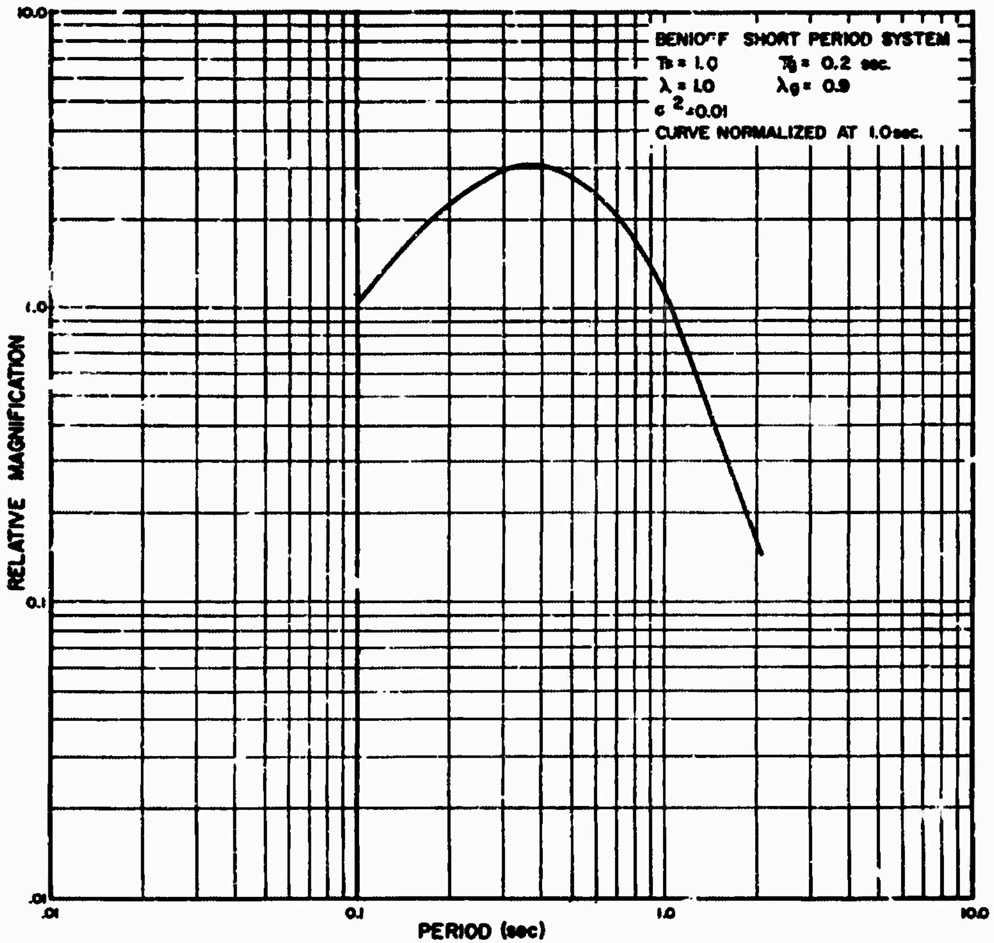
Pick <u>time</u> of <u>Pn</u> at beginning of "a" half cycle.

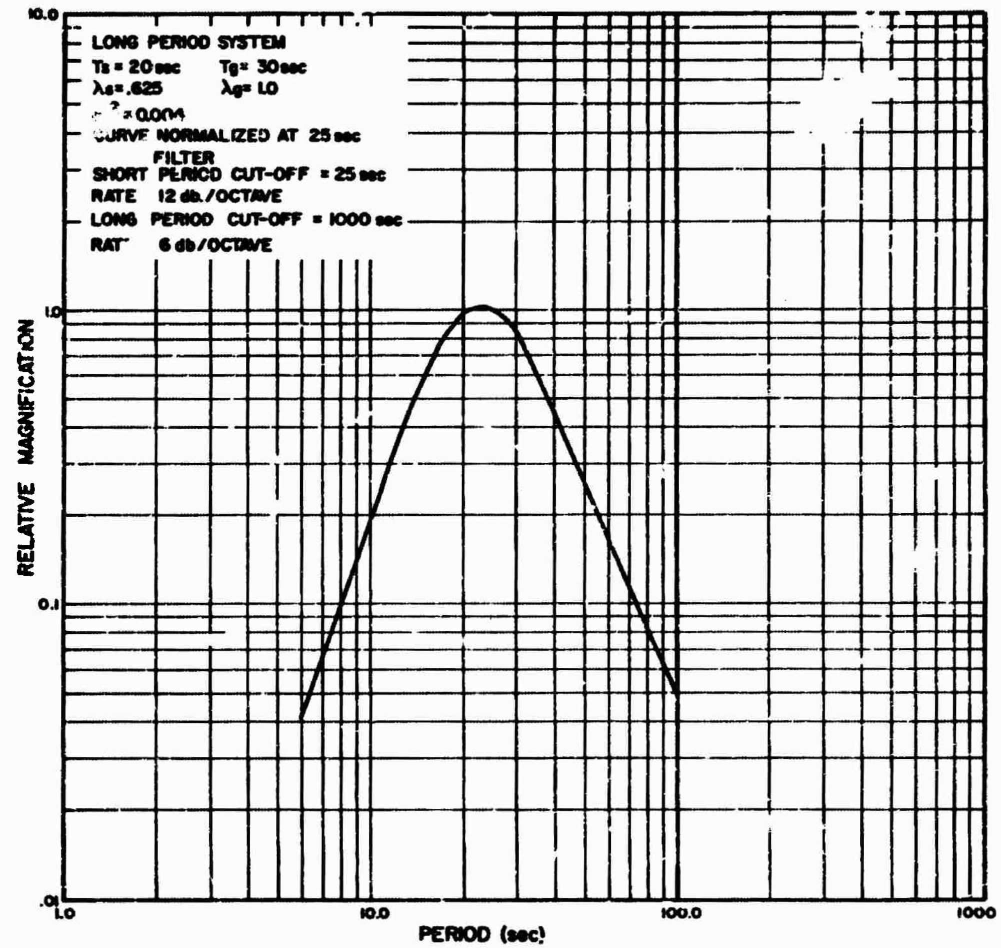
Pick <u>amplitude</u> of <u>Pn</u> as maximum "$d/2$" within 2 or 3 cycles of "c".

Pick <u>amplitudes</u> of <u>Pg</u> and <u>Lg</u> at maximum of corresponding motion.

Seismic Analysis Diagram

APPENDIX II(A)





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DOCUMENT CONTROL DATA - R&D

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3. REPORT TITLE

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4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Scientific Report

5. AUTHOR(S) (Last name, first name, initial)

Clark, Don M.

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8a. CONTRACT OR GRANT NO. AF 33(657)-12447 b. PROJECT NO. VELA T/2037 c. ARPA Order No. 624 d. ARPA Program Code No. 5810	9a. ORIGINATOR'S REPORT NUMBER(S) SDL Report No. 137 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) --

10. AVAILABILITY/LIMITATION NOTICES

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11. SUPPLEMENTARY NOTES --	12. SPONSORING MILITARY ACTIVITY ADVANCED RESEARCH PROJECTS AGENCY NUCLEAR TEST DETECTION OFFICE WASHINGTON, D. C.

13. ABSTRACT

An analysis of an underwater HE shot as a continuing study to provide information to aid in distinguishing between earthquakes and explosions. A table of travel times and amplitudes of identified as well as unidentified phases is included.

DD FORM 1 JAN 64 1473

Unclassified
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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Seismic Magnitude						
Seismic Travel-Time						
Seismic Amplitude						
VELA-UNIFORM						
Chemical Explosion - CHASE IV						

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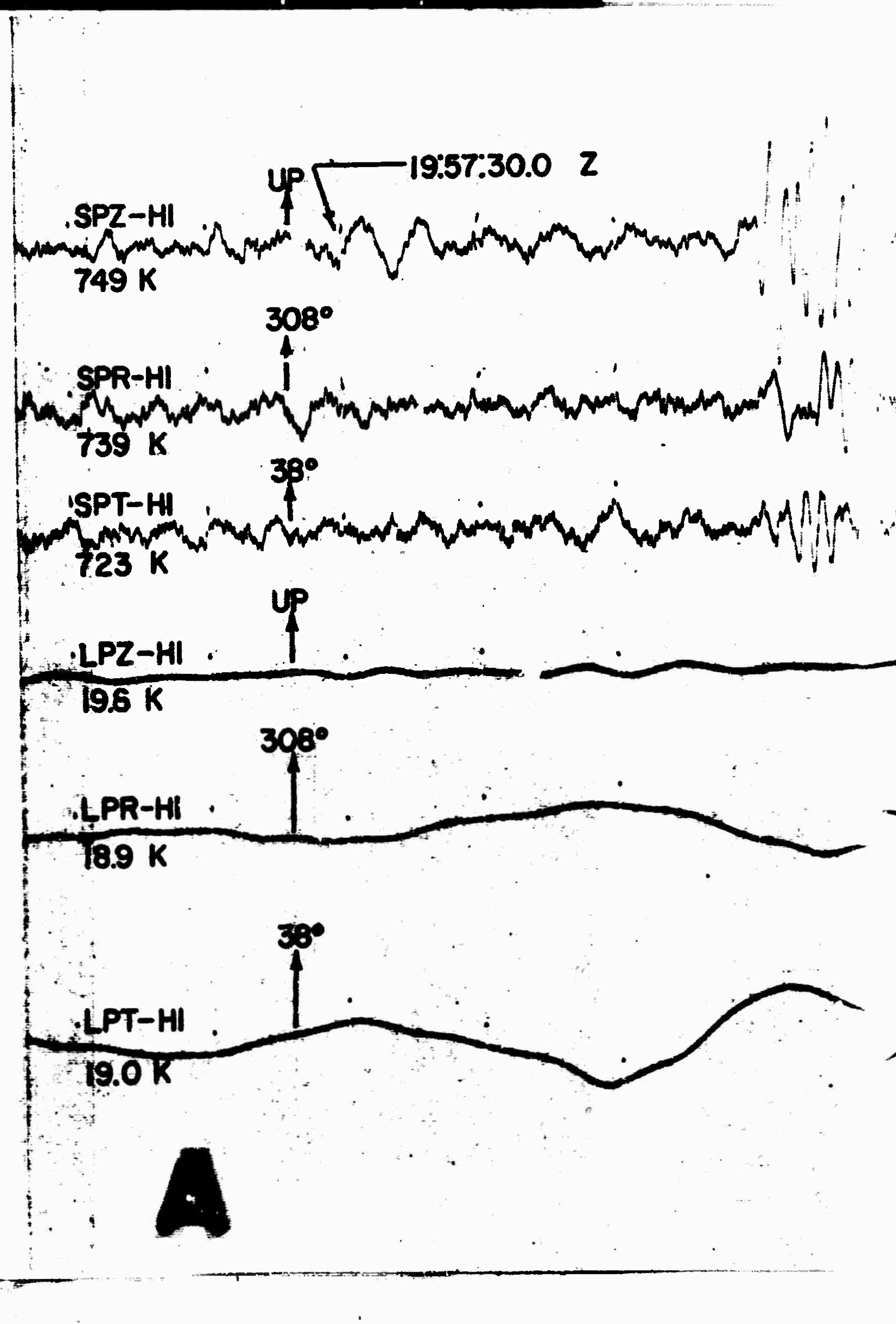
CHASE IV

MN-NV

Mina, Nevada

16 September 1965

Δ = 3815 km



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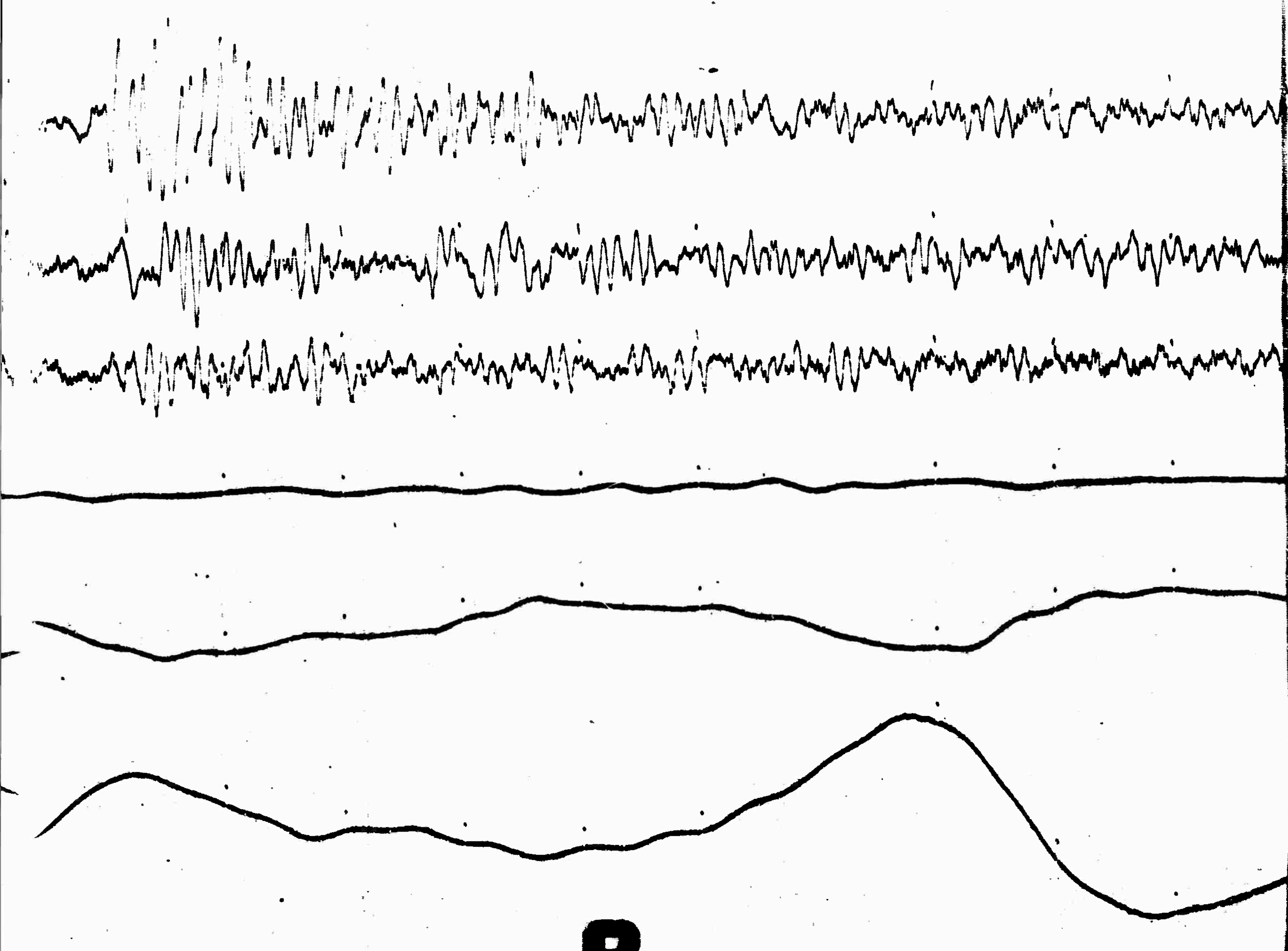

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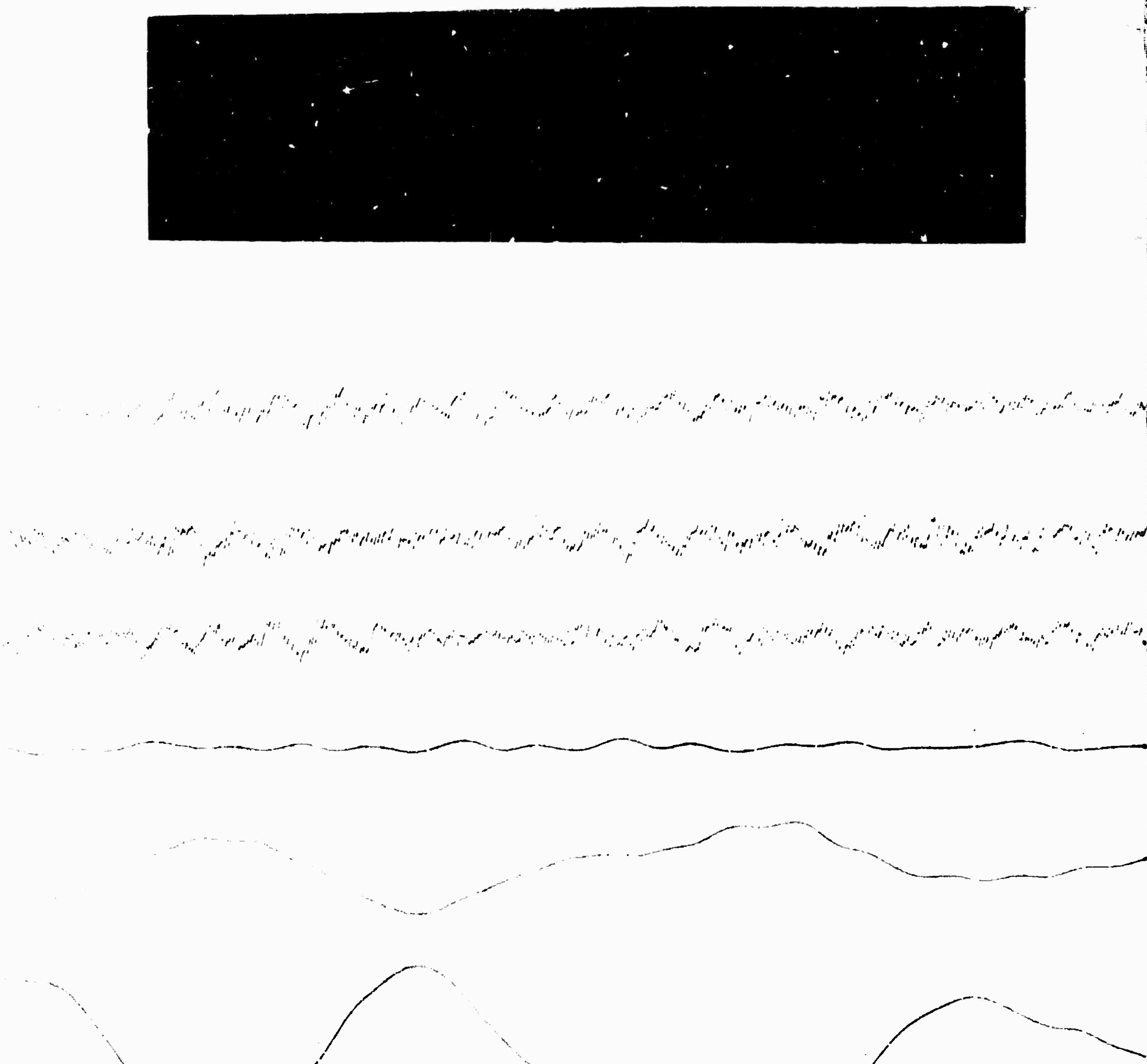

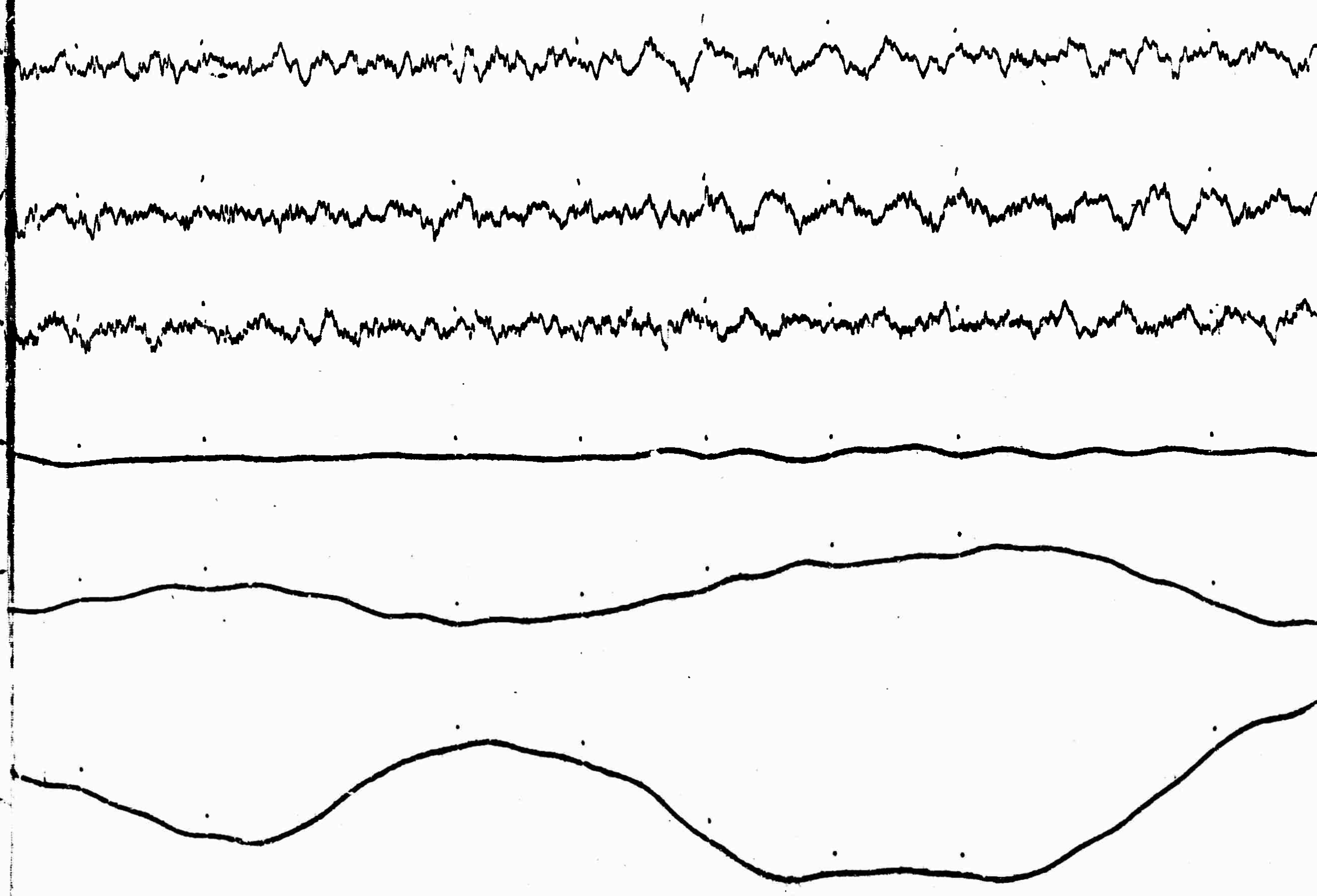

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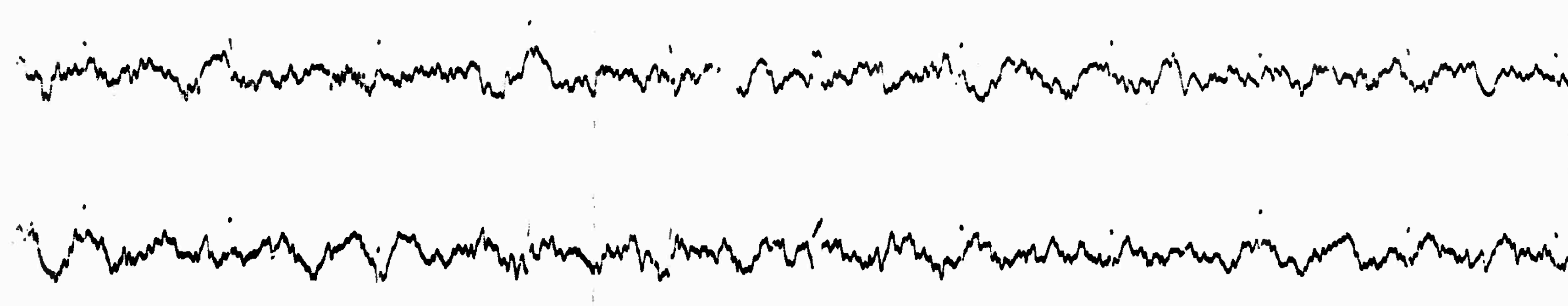

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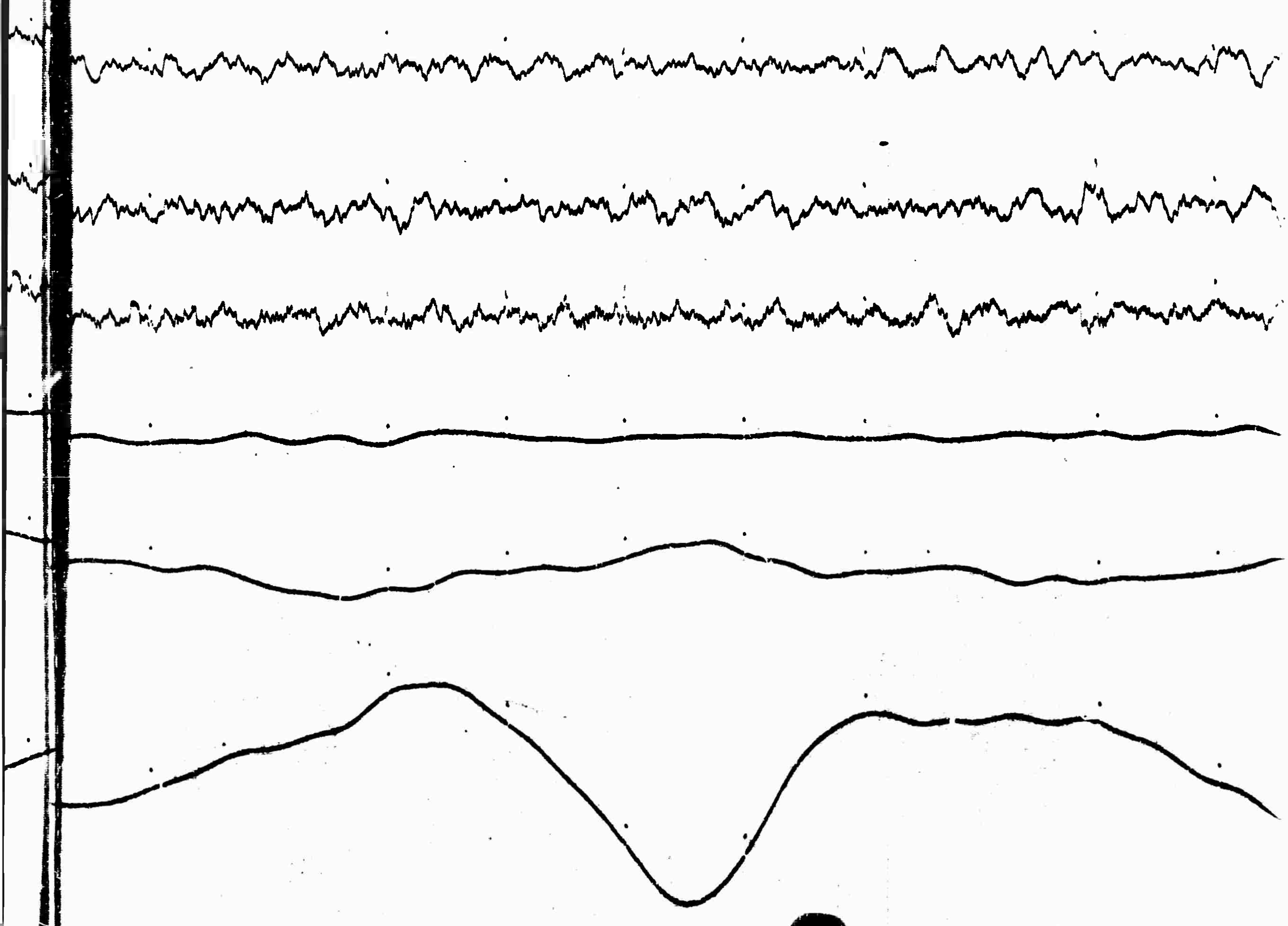

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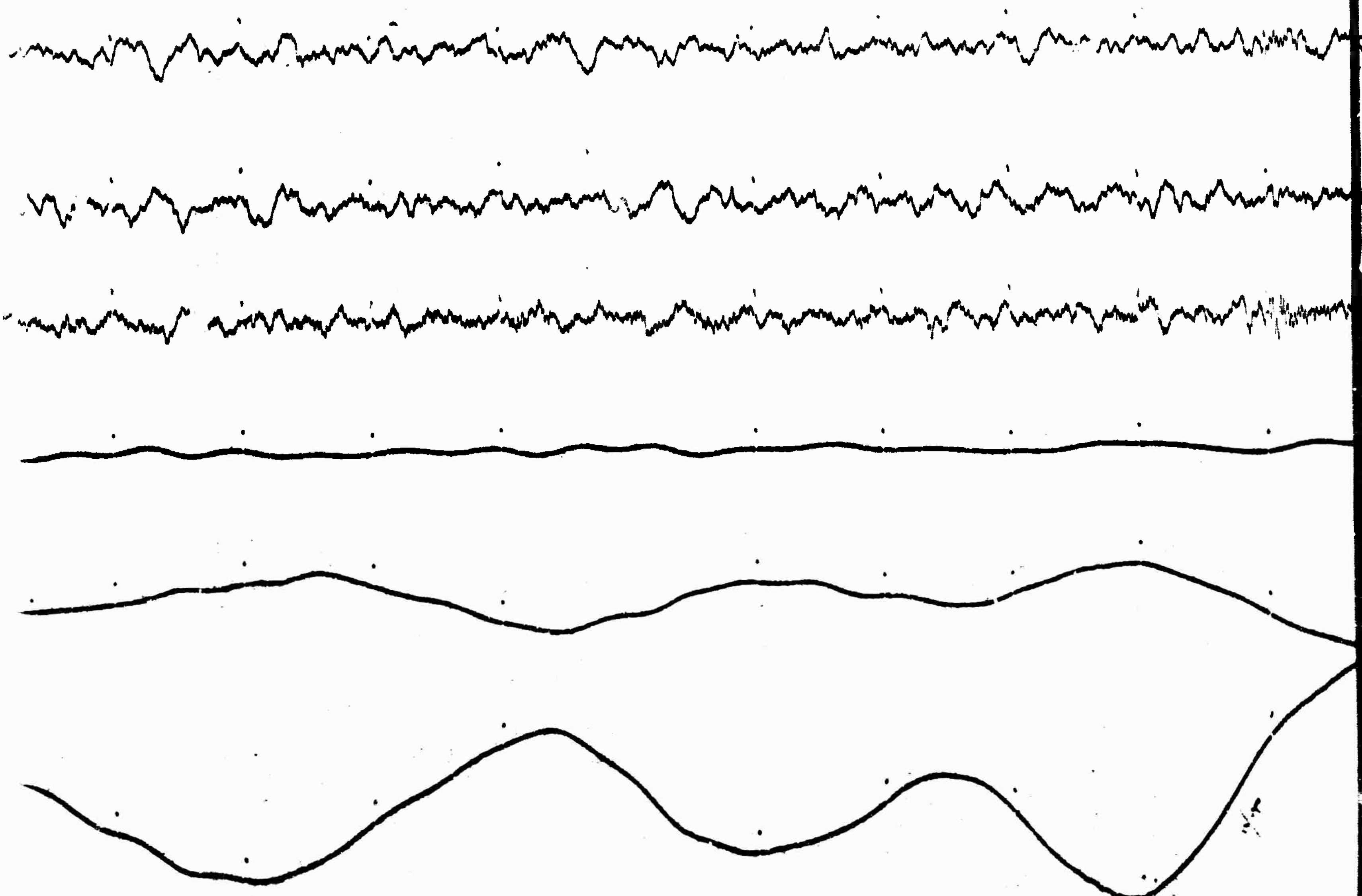

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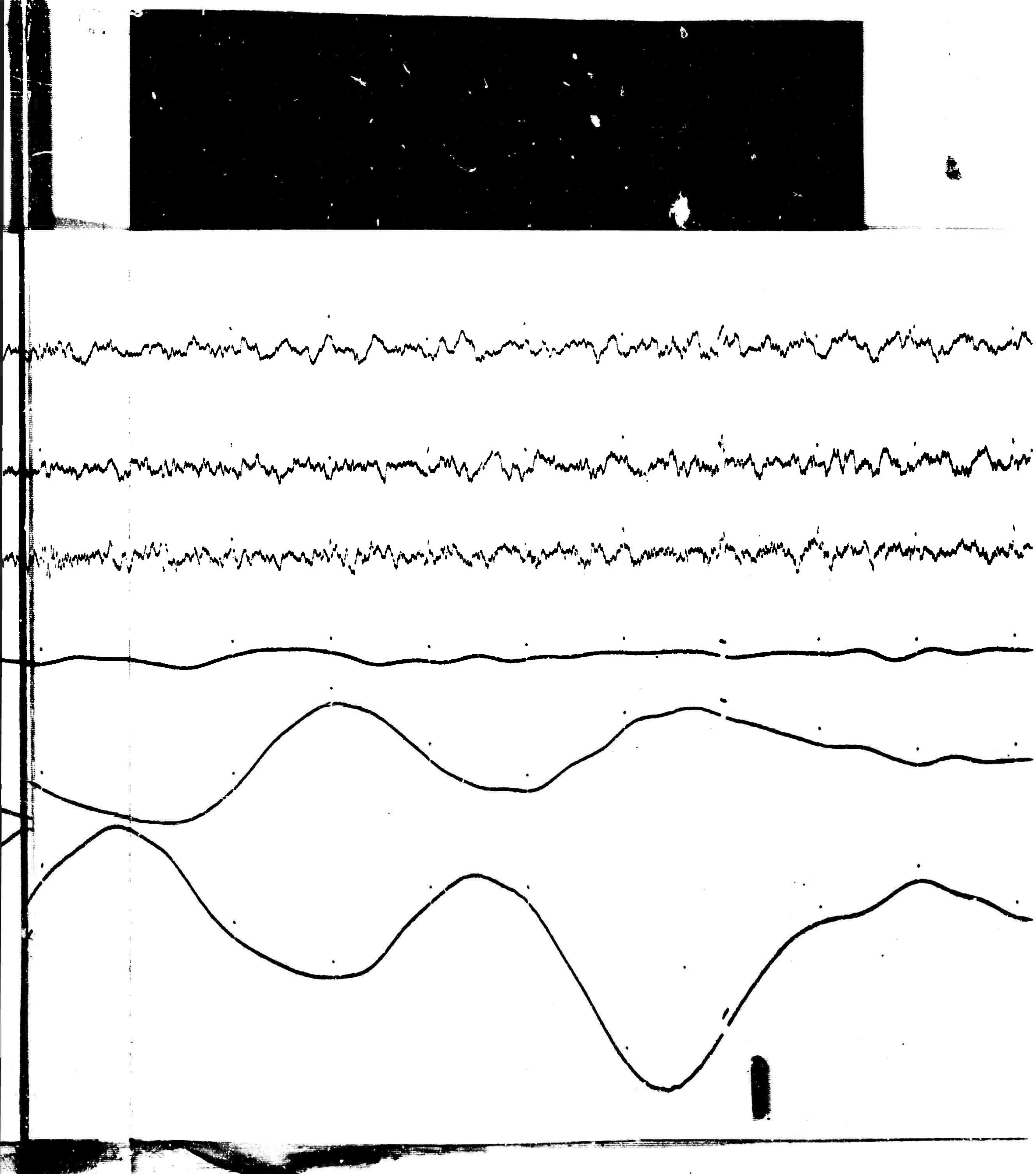

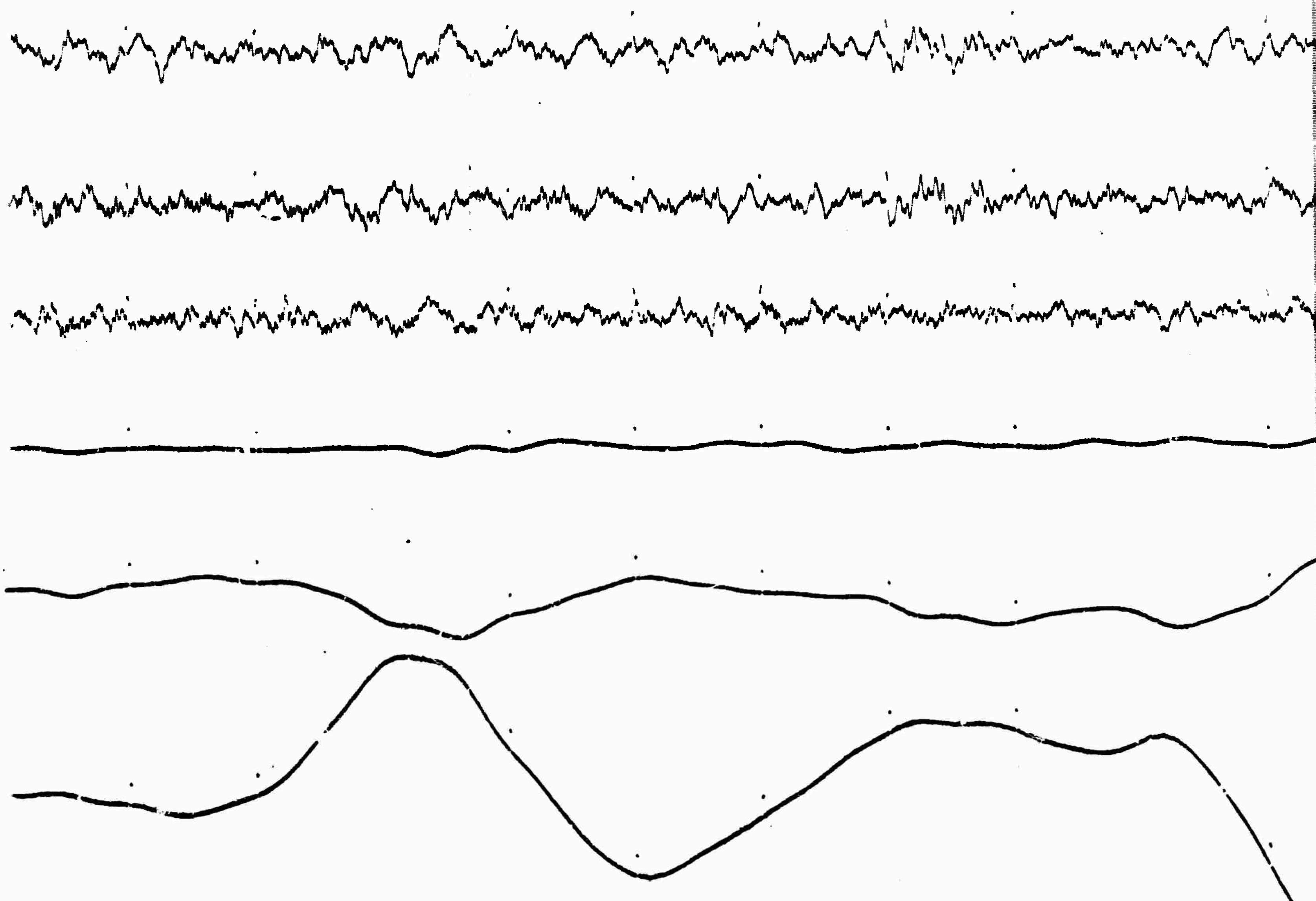

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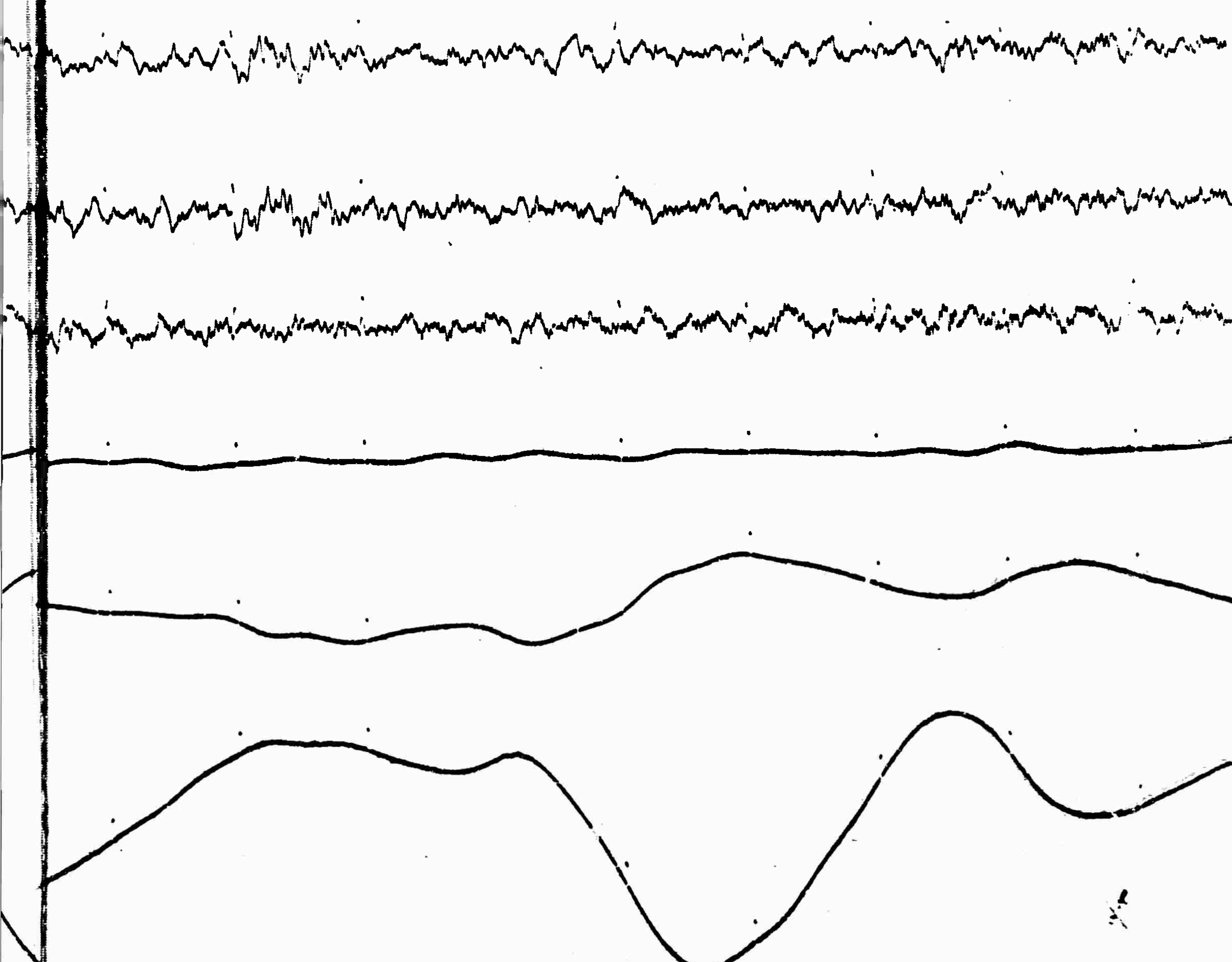

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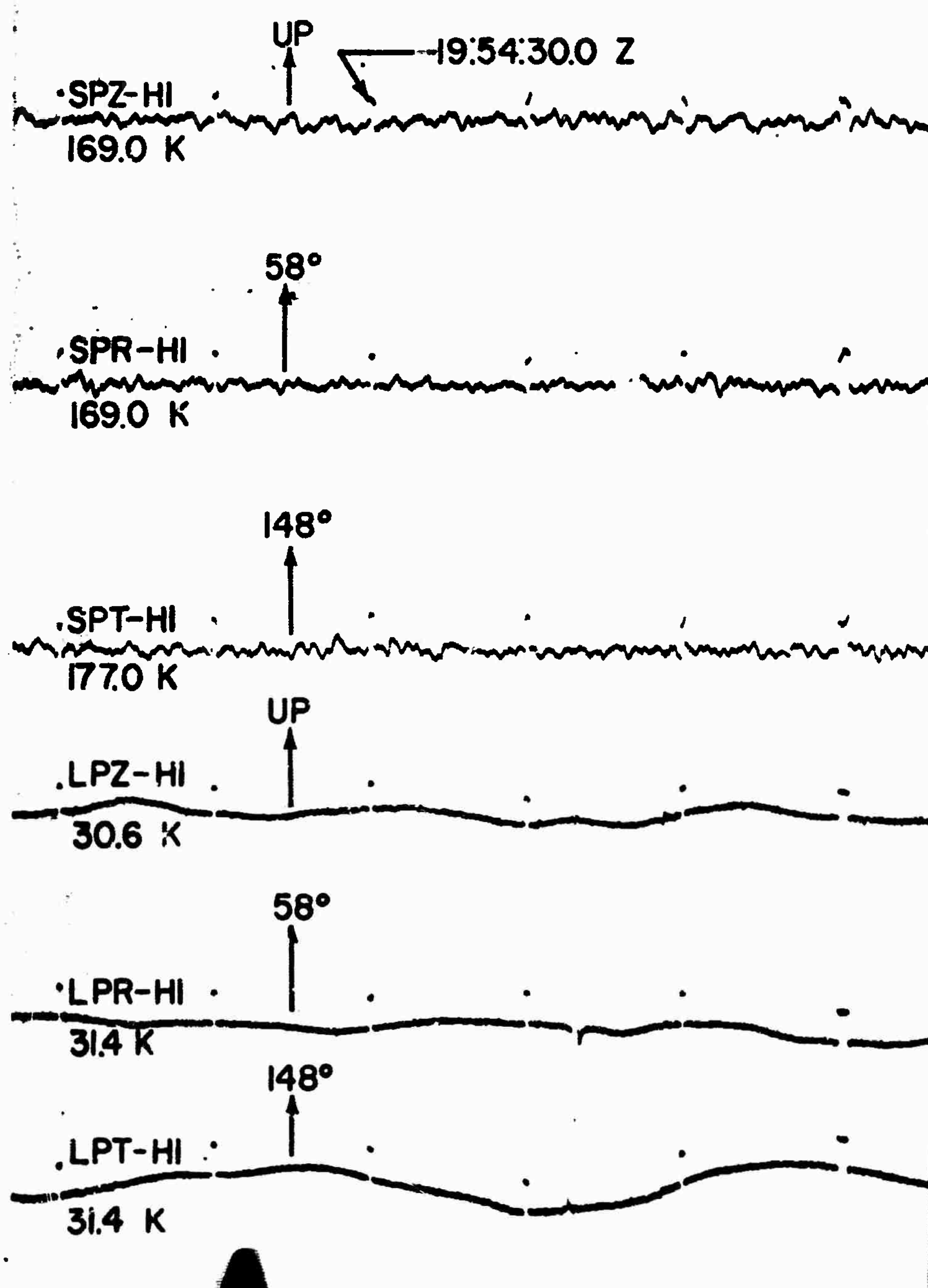
CHASE IV

RK-ON

Red Lake, Ontario

16 September 1965

Δ = 2151 km



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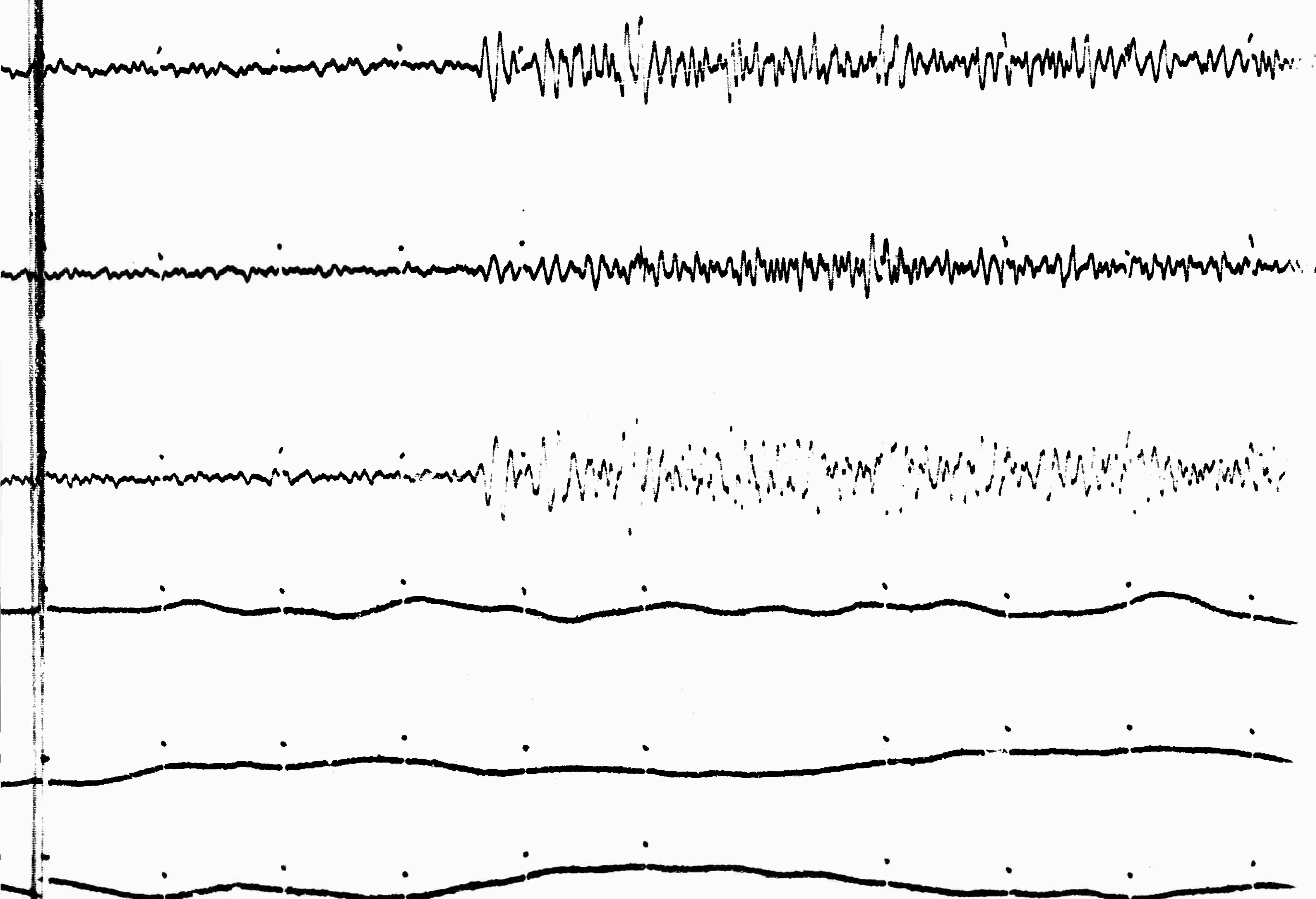

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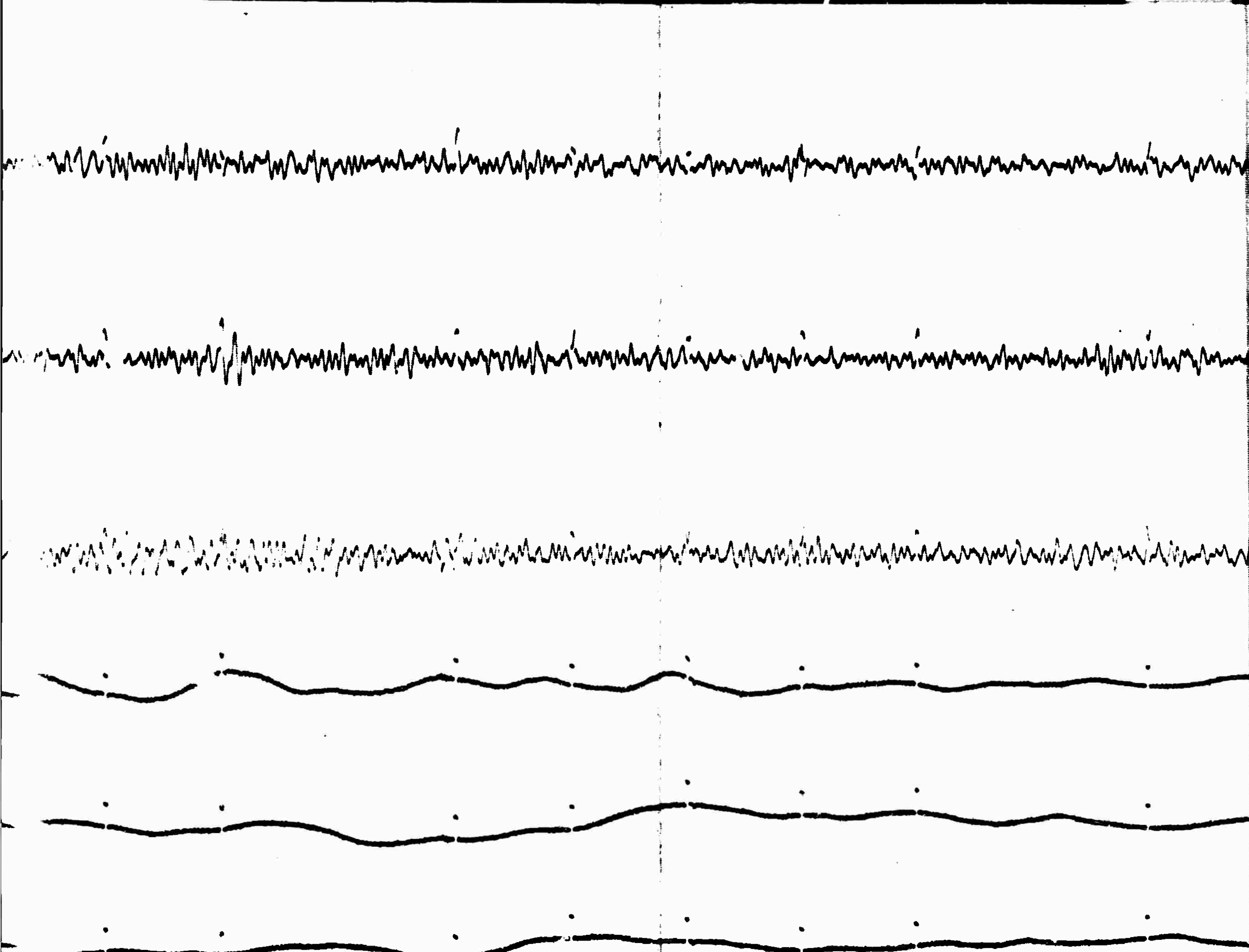

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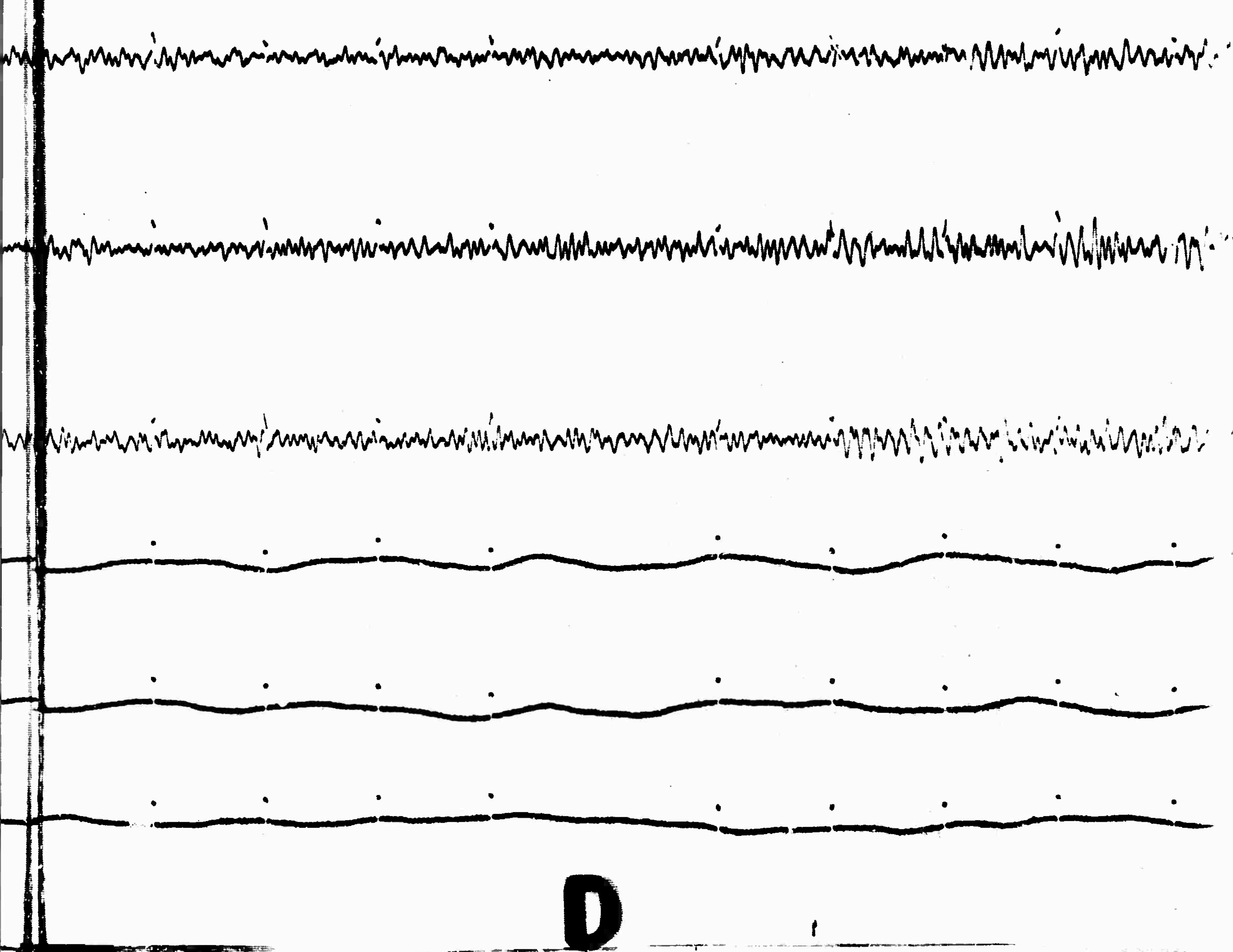

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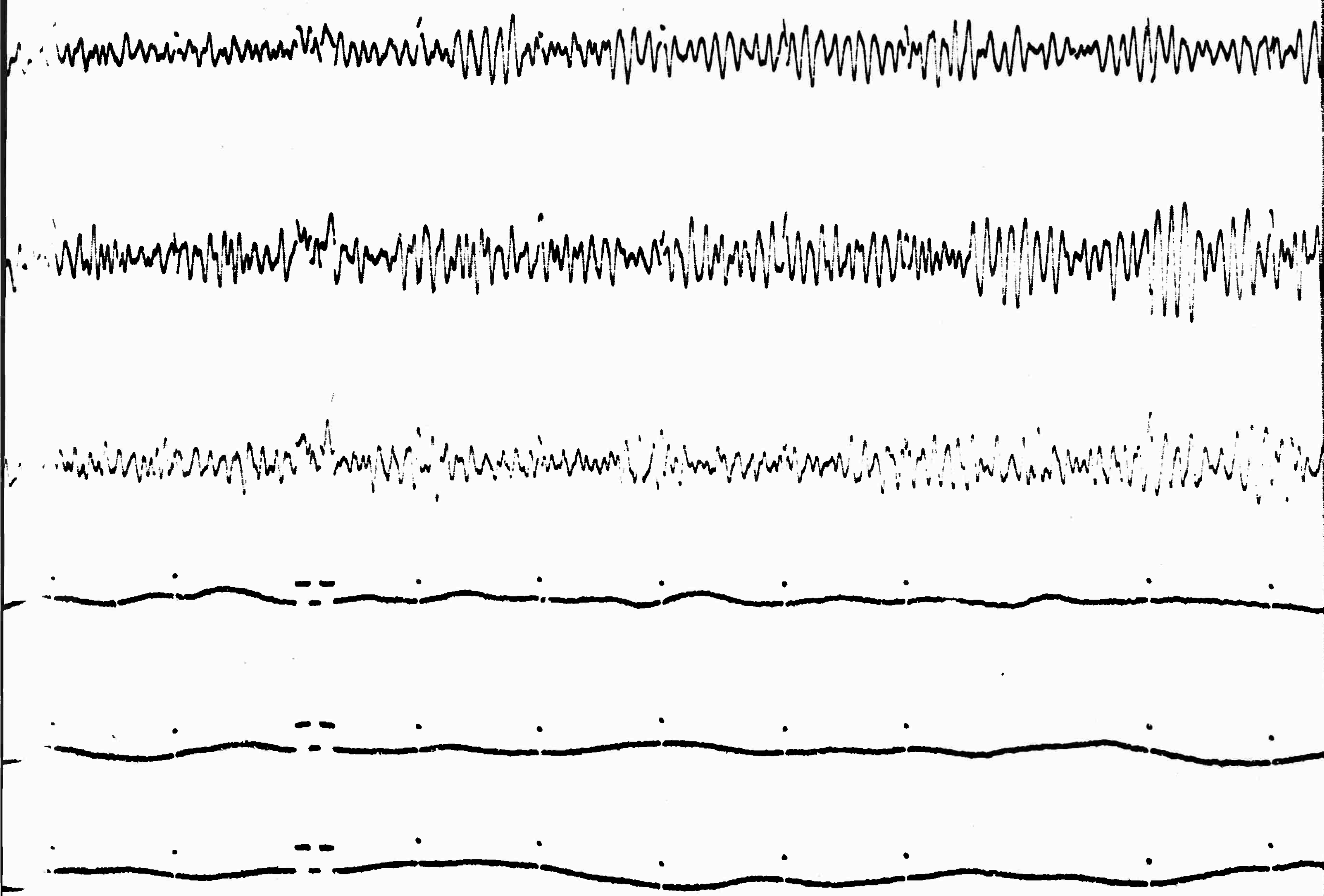

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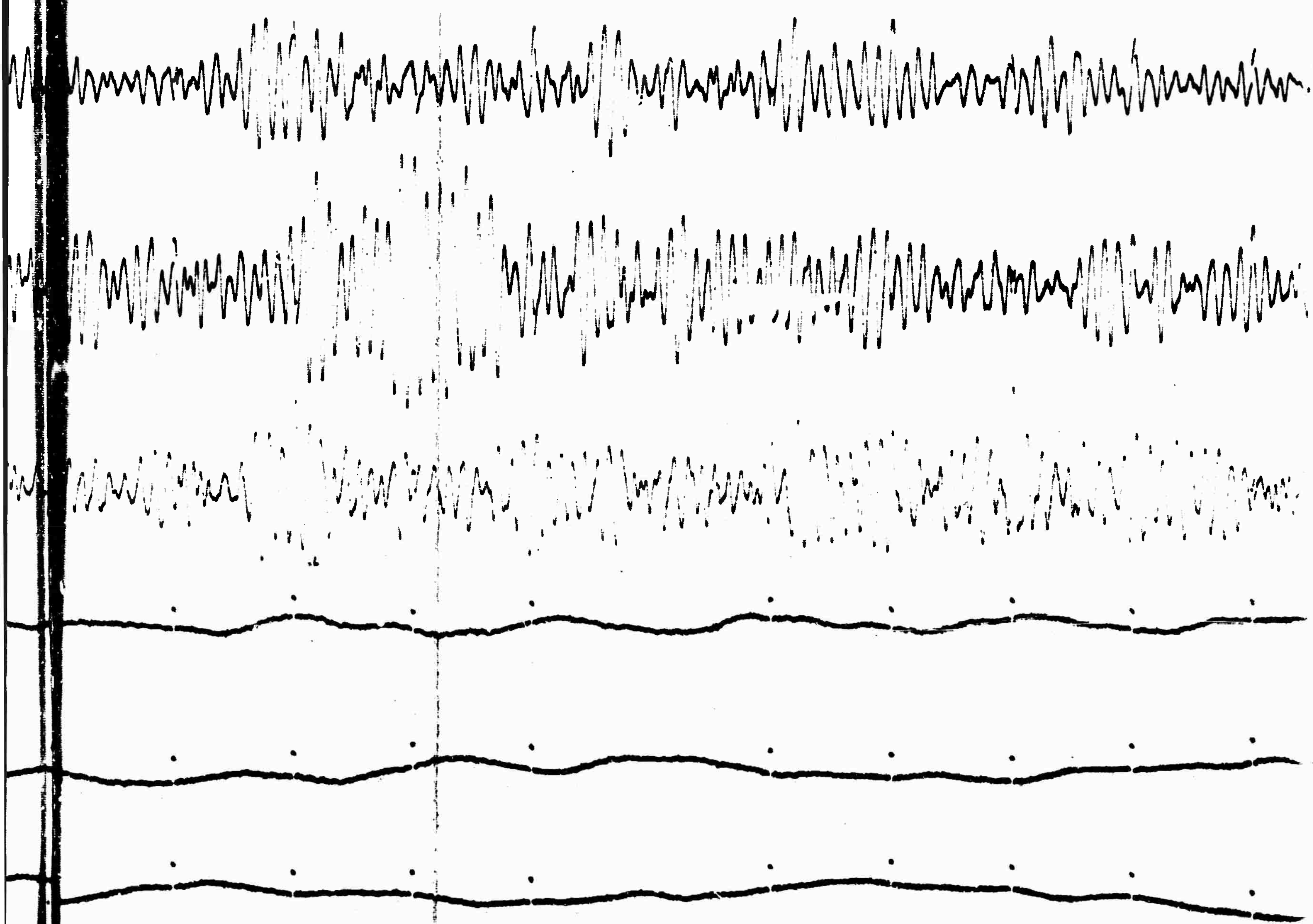

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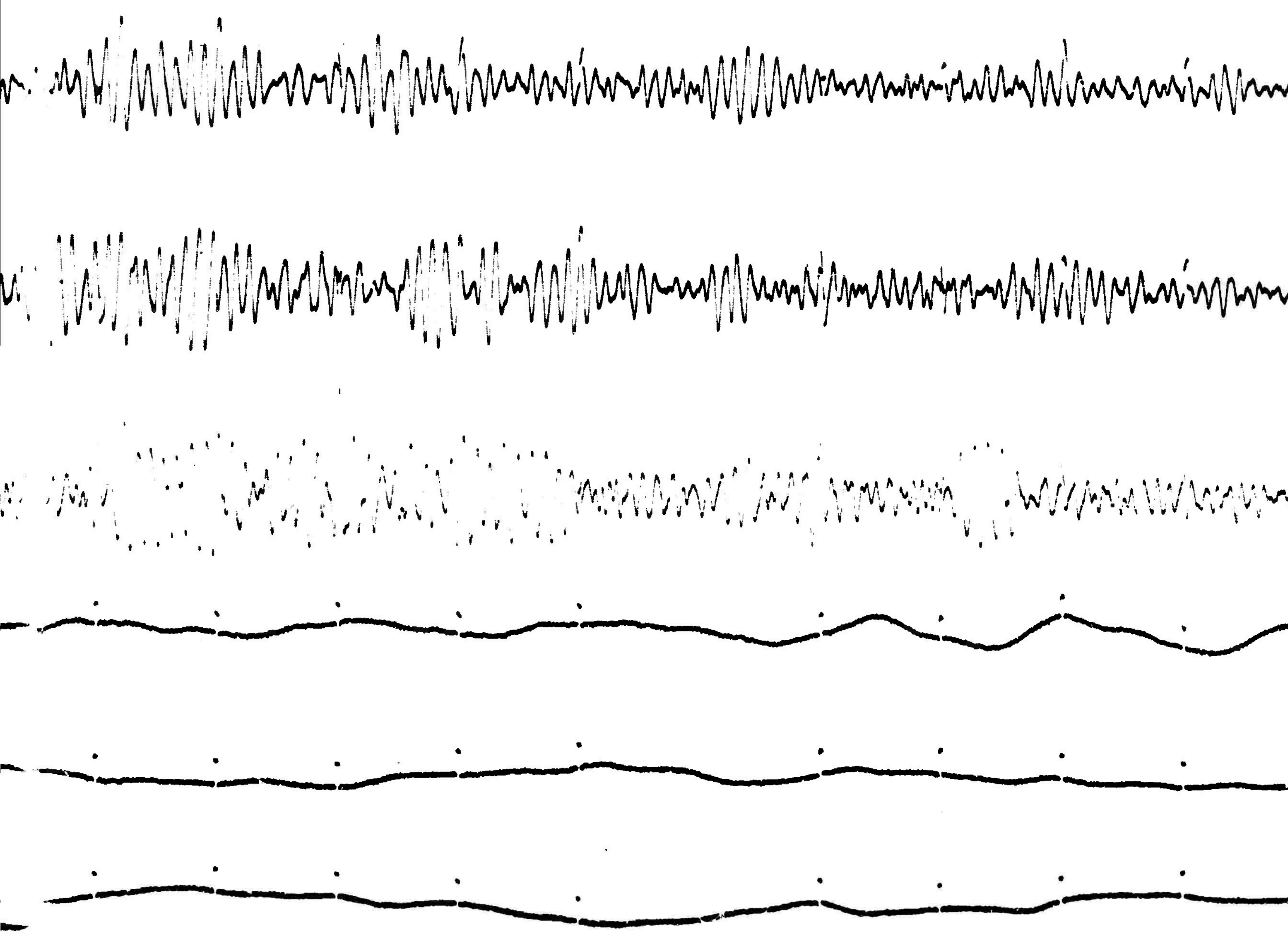

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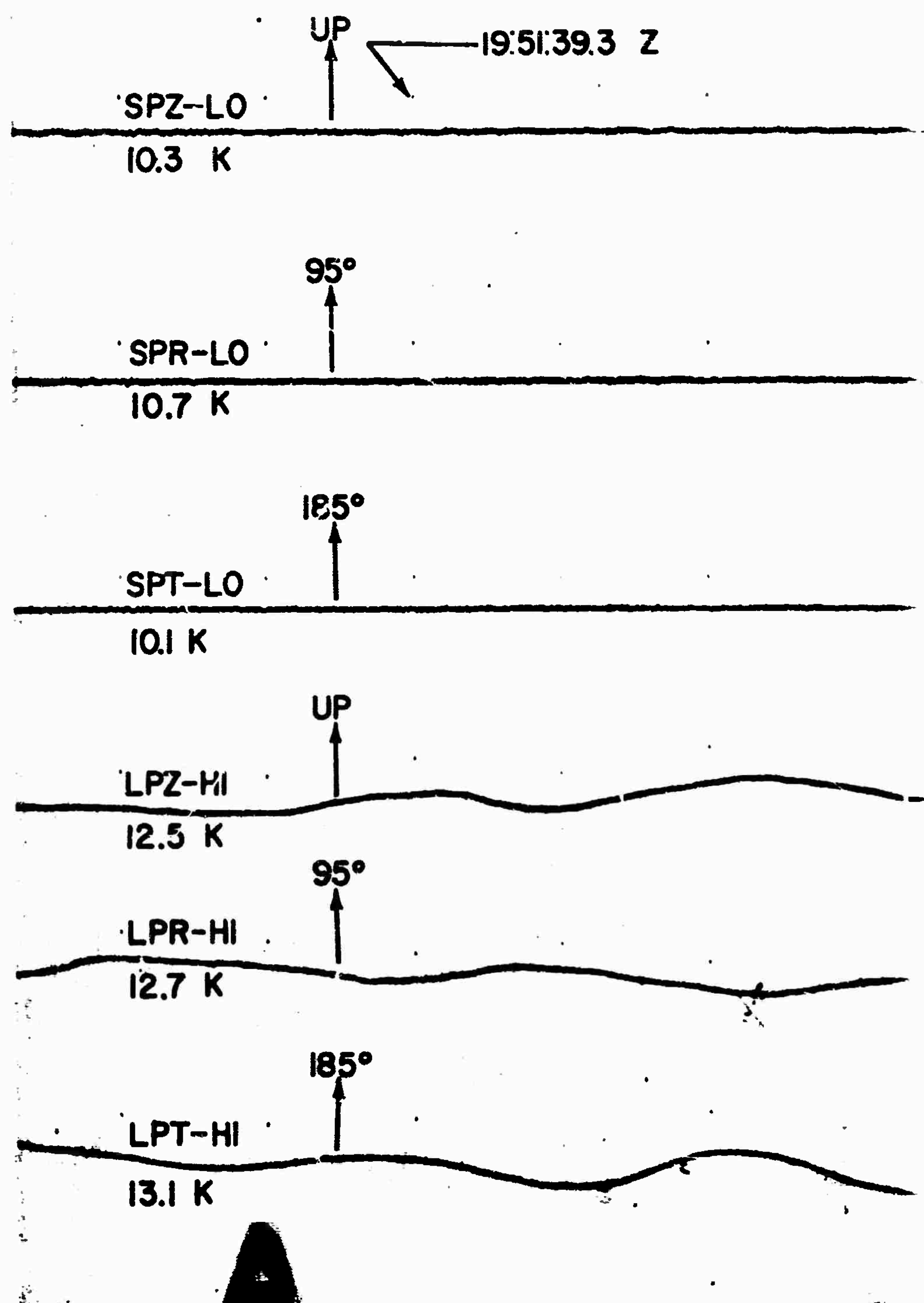


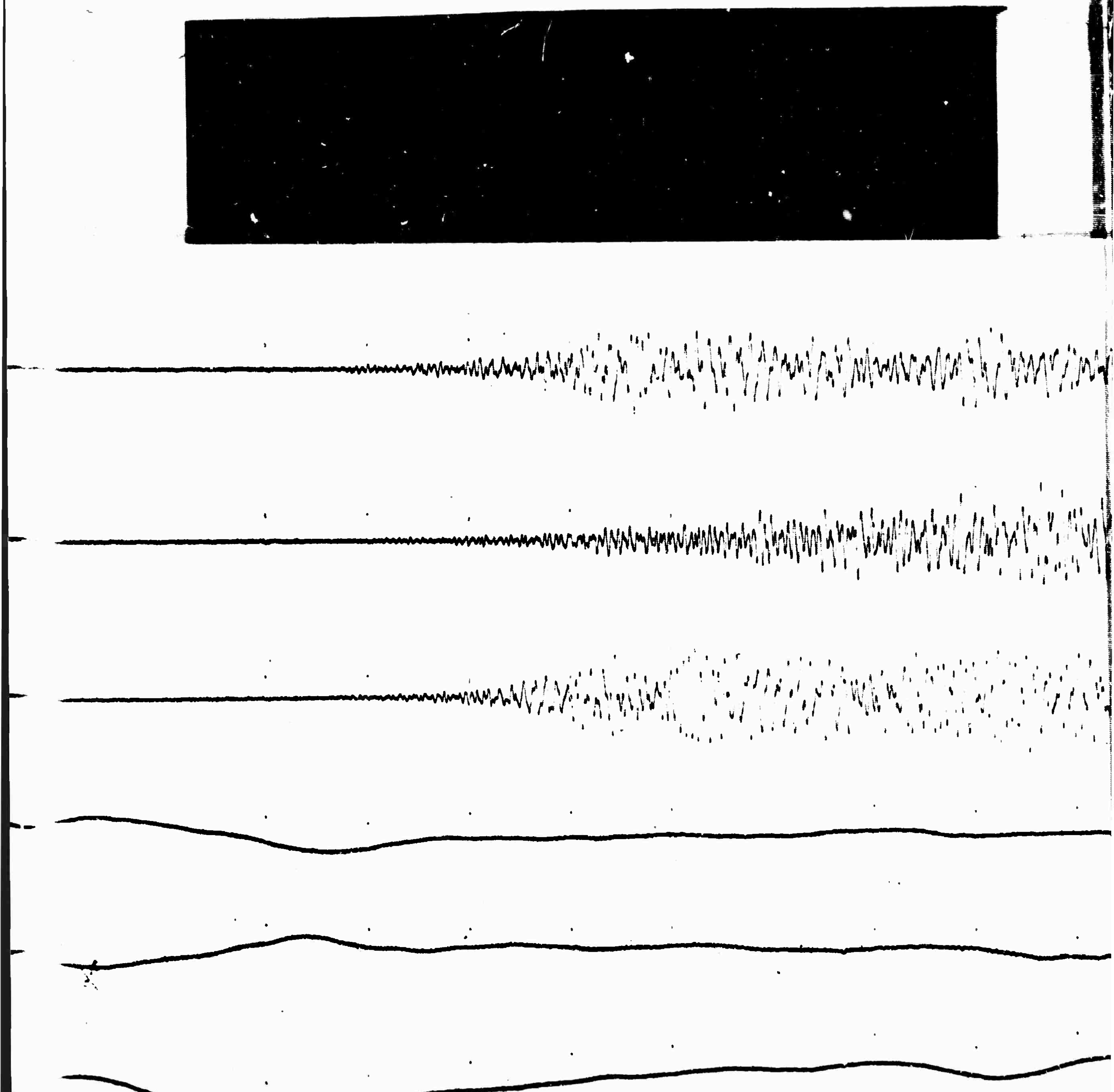
CHASE IV

DH-NY

Delhi, New York

6 September 1965

$\Delta = 562$ km



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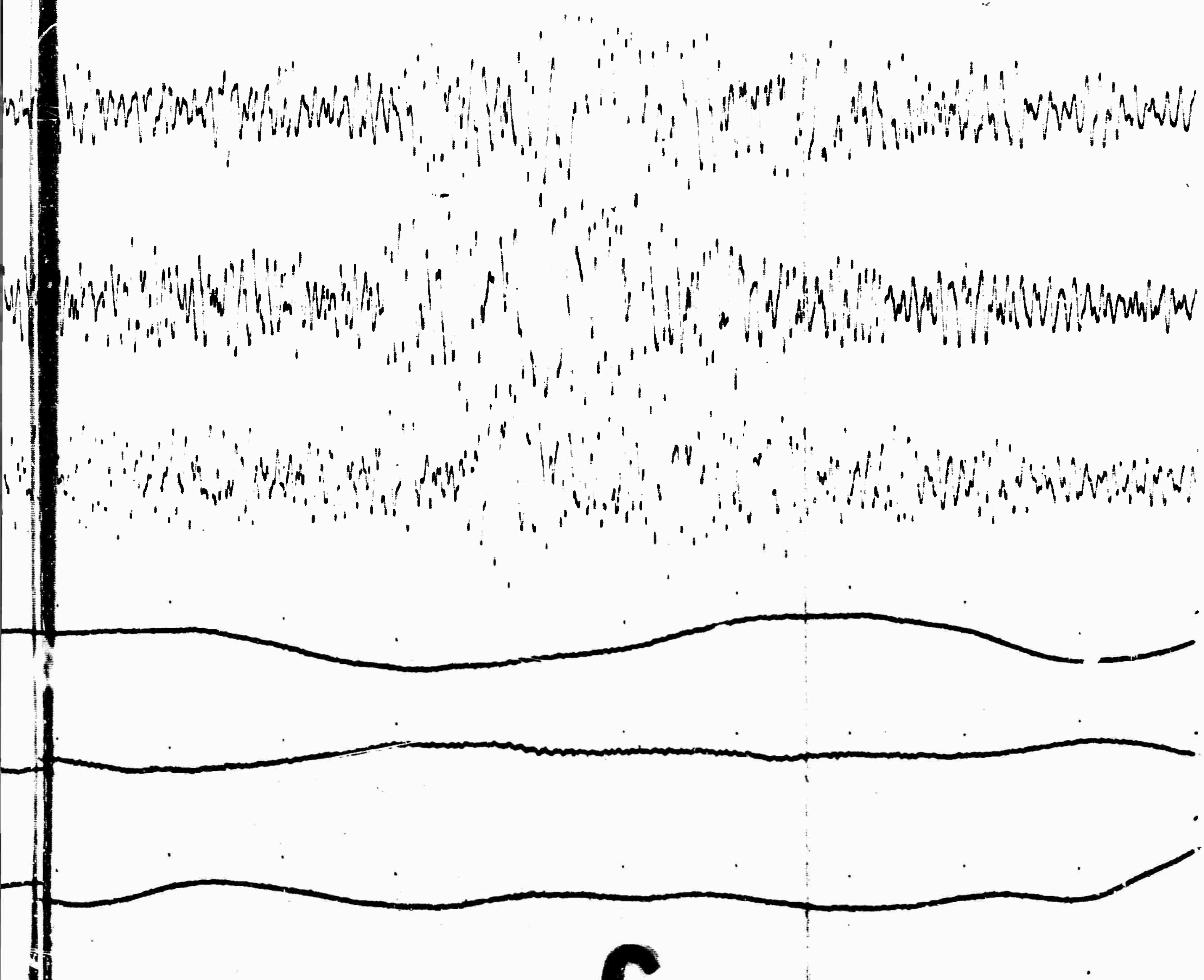

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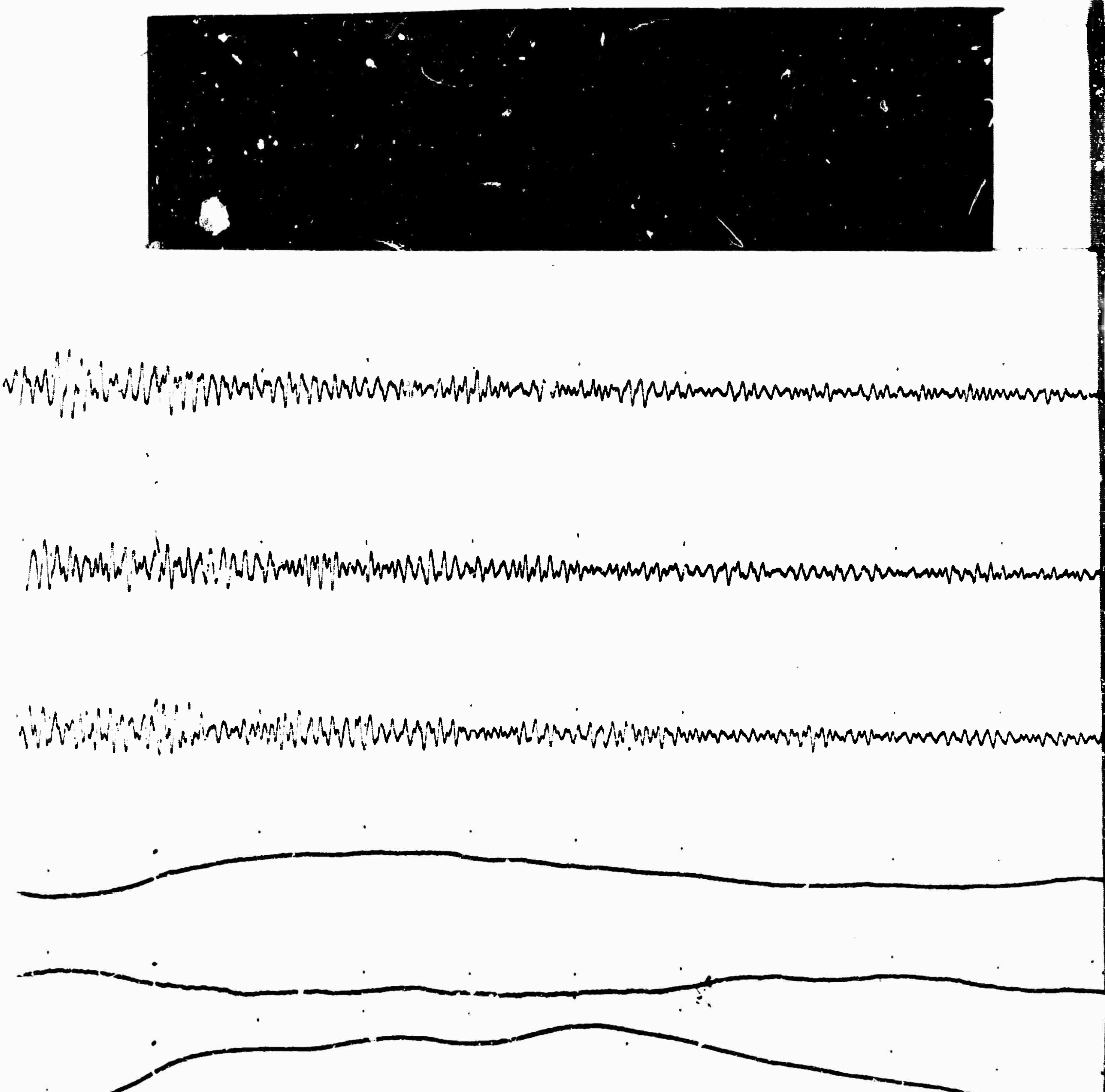

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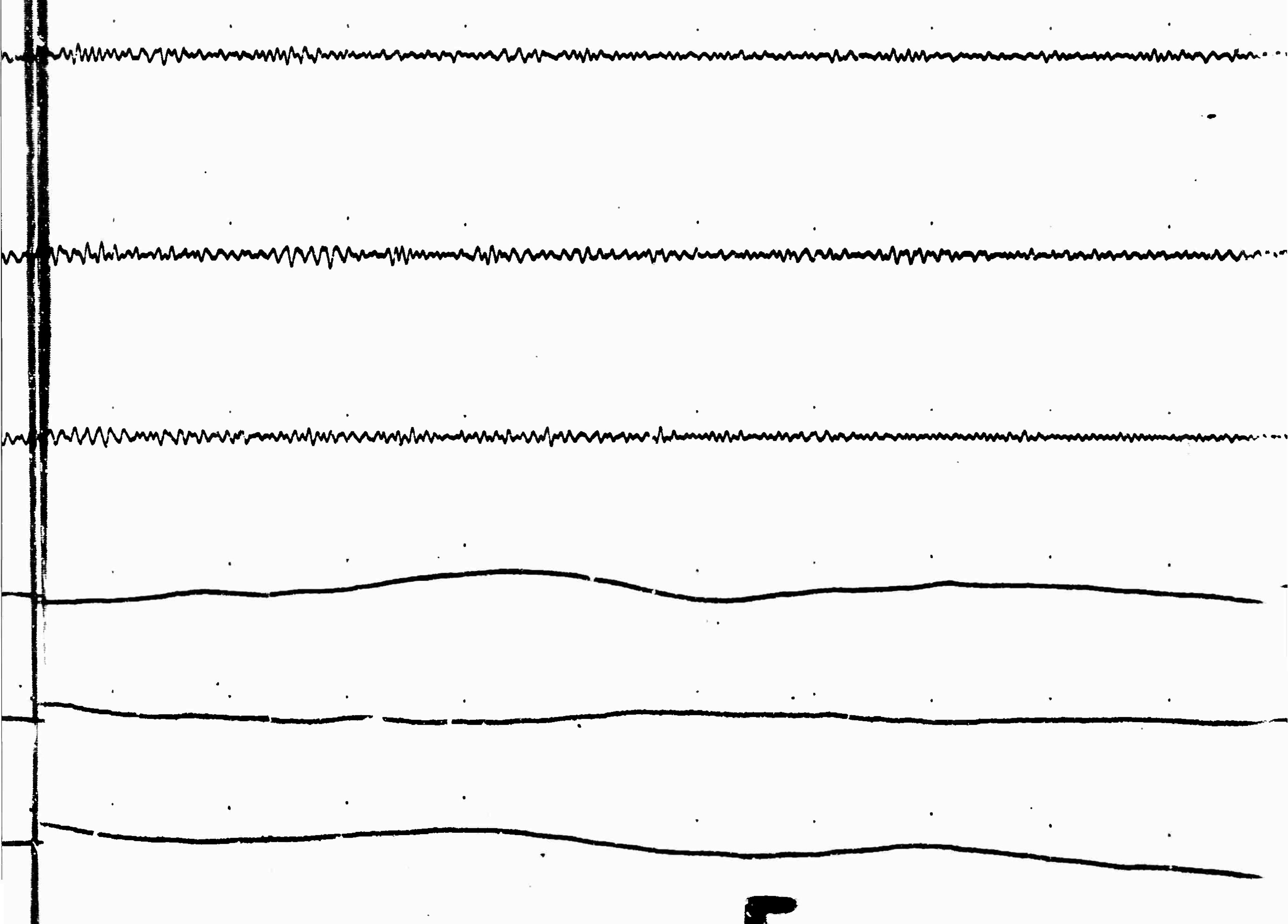

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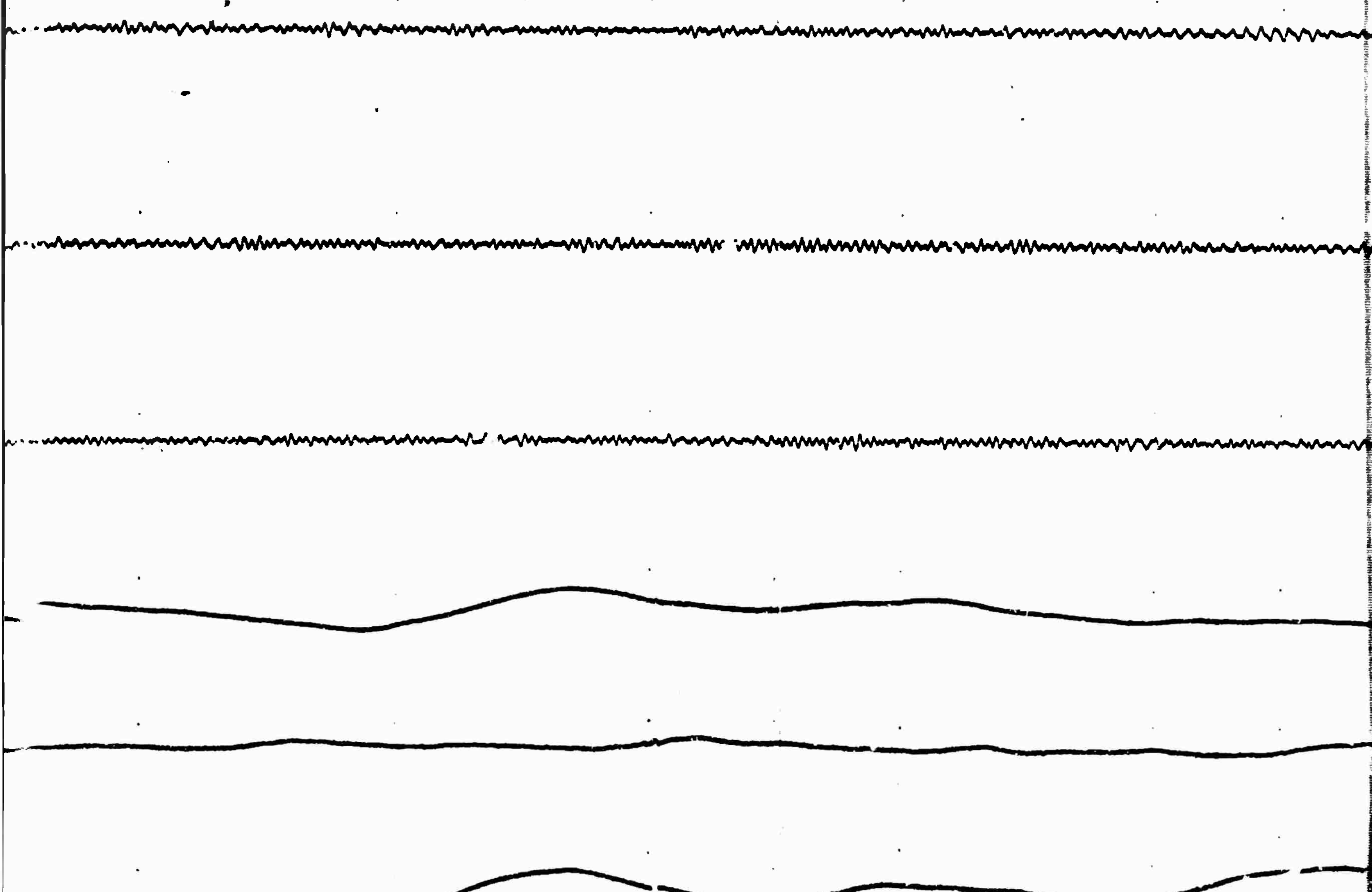

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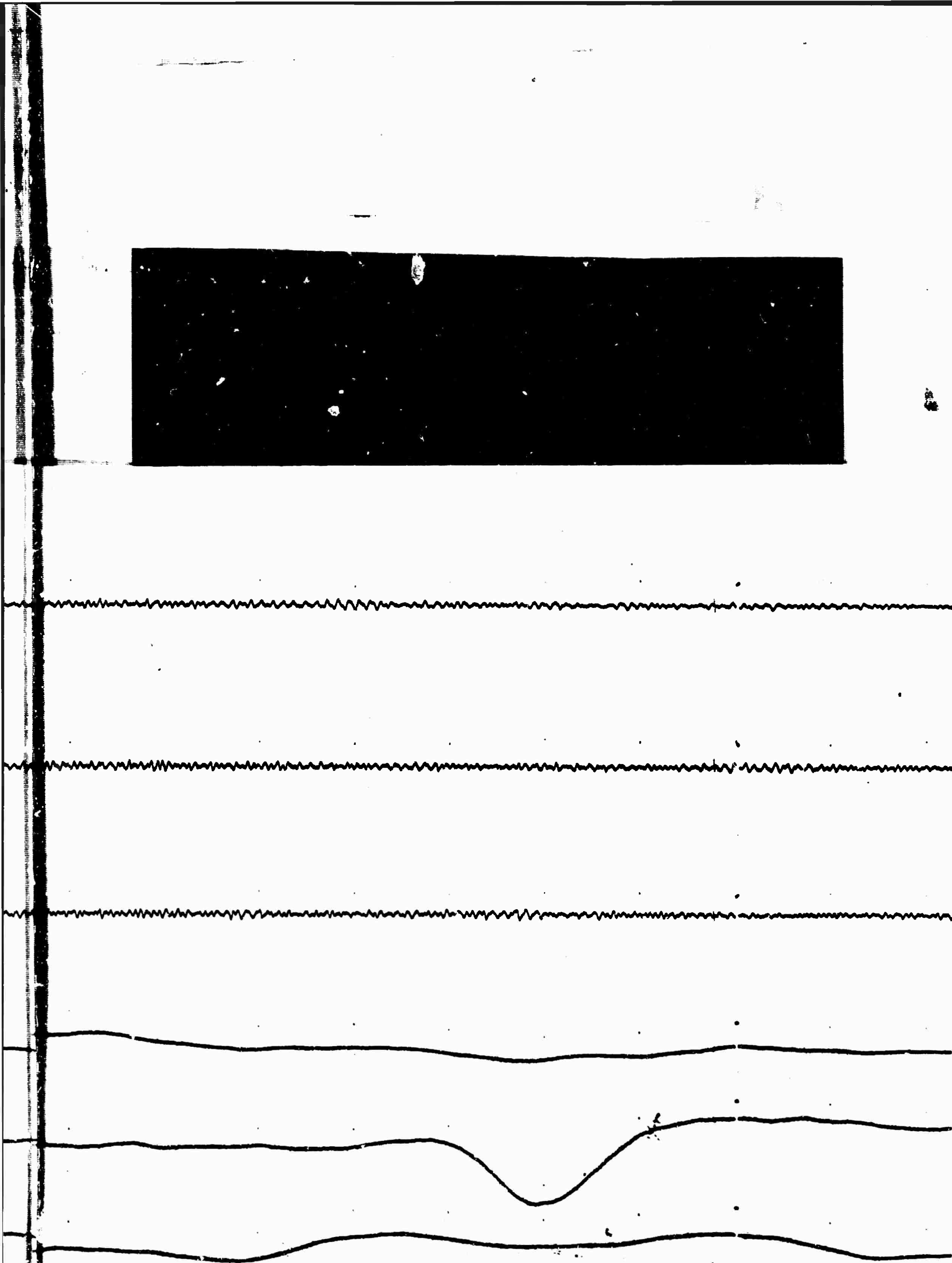

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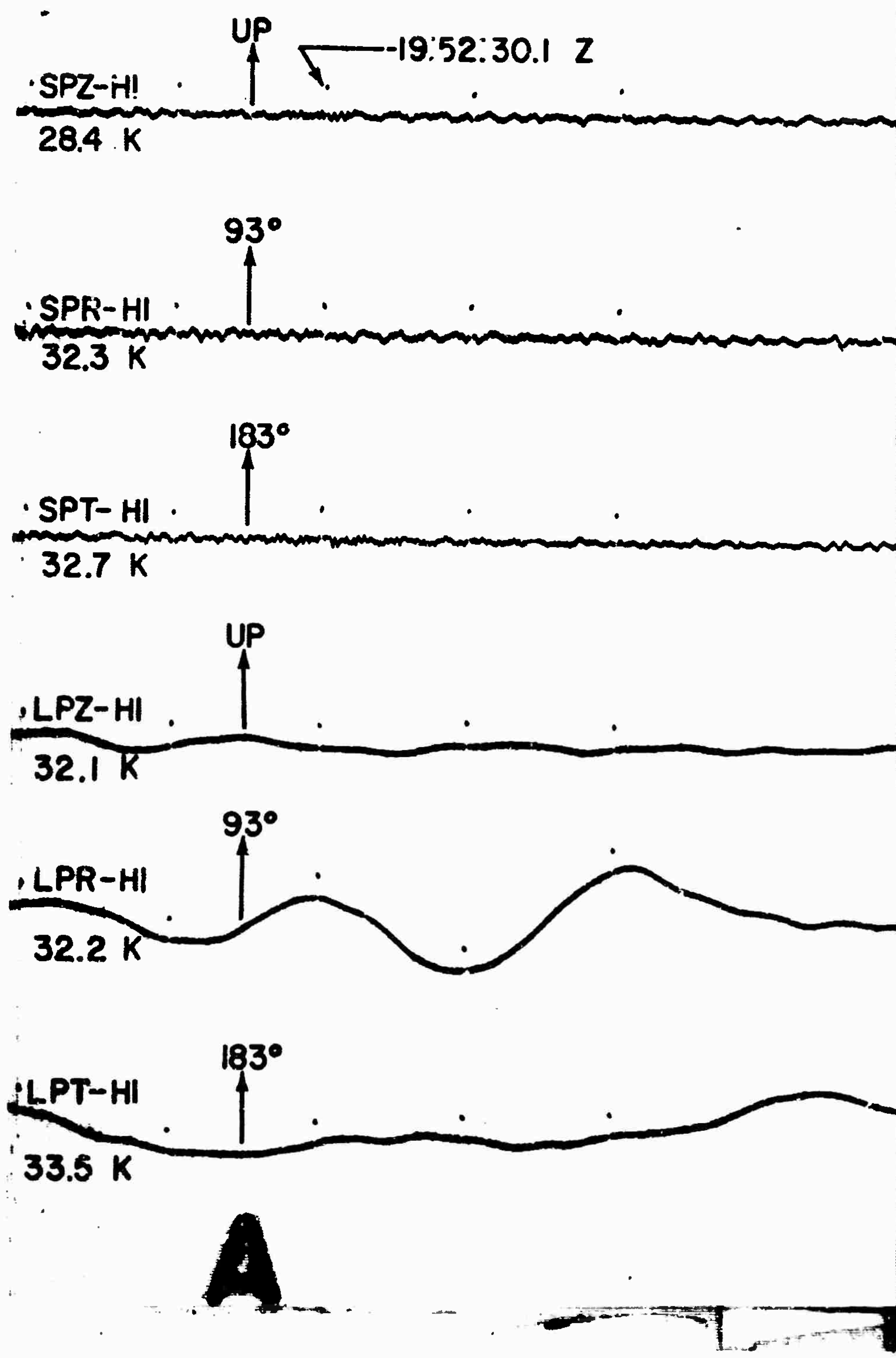
CHASE IV

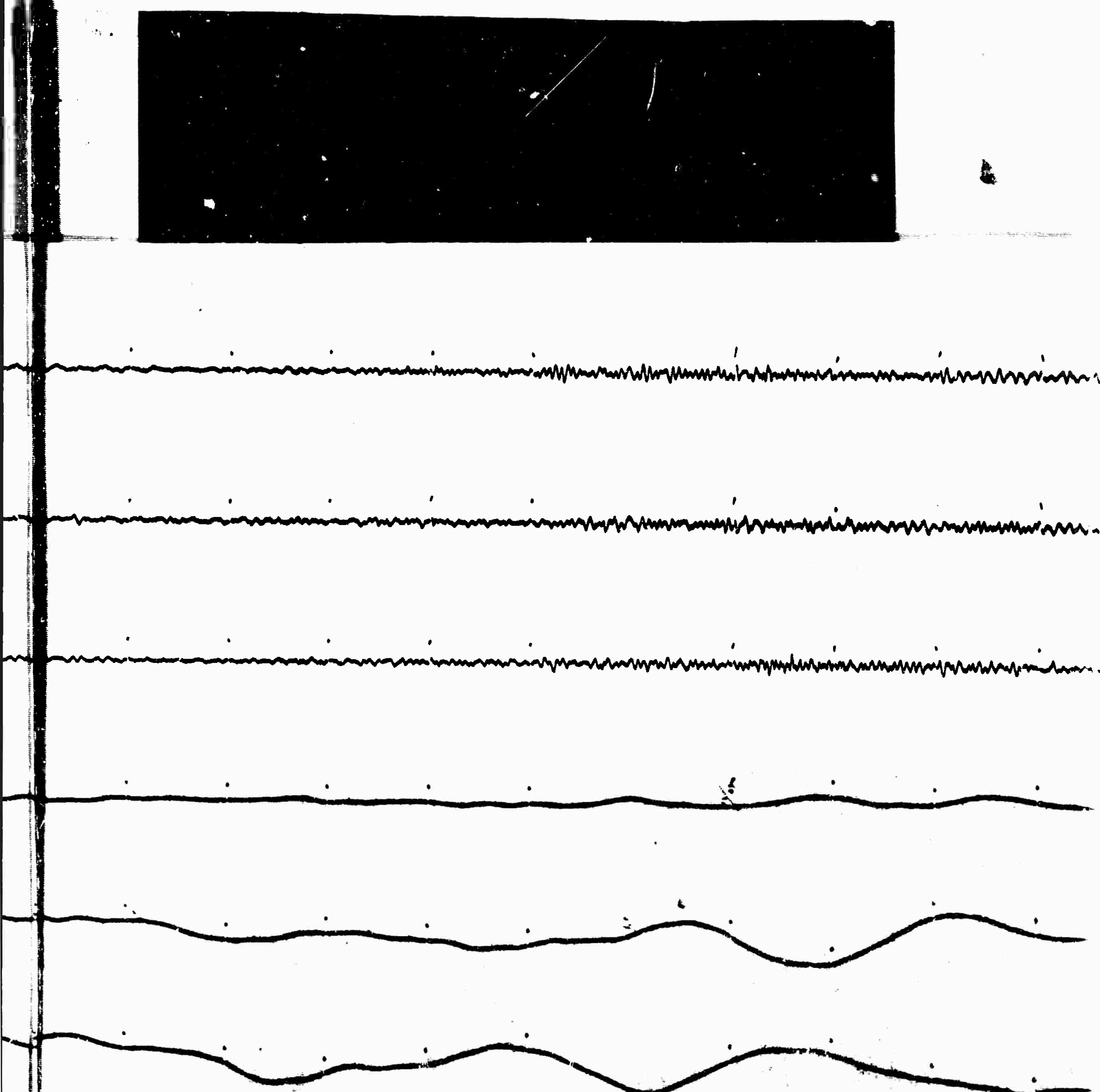
HN-ME

Houlton, Maine

16 September 1965

$\Delta = 290$ km





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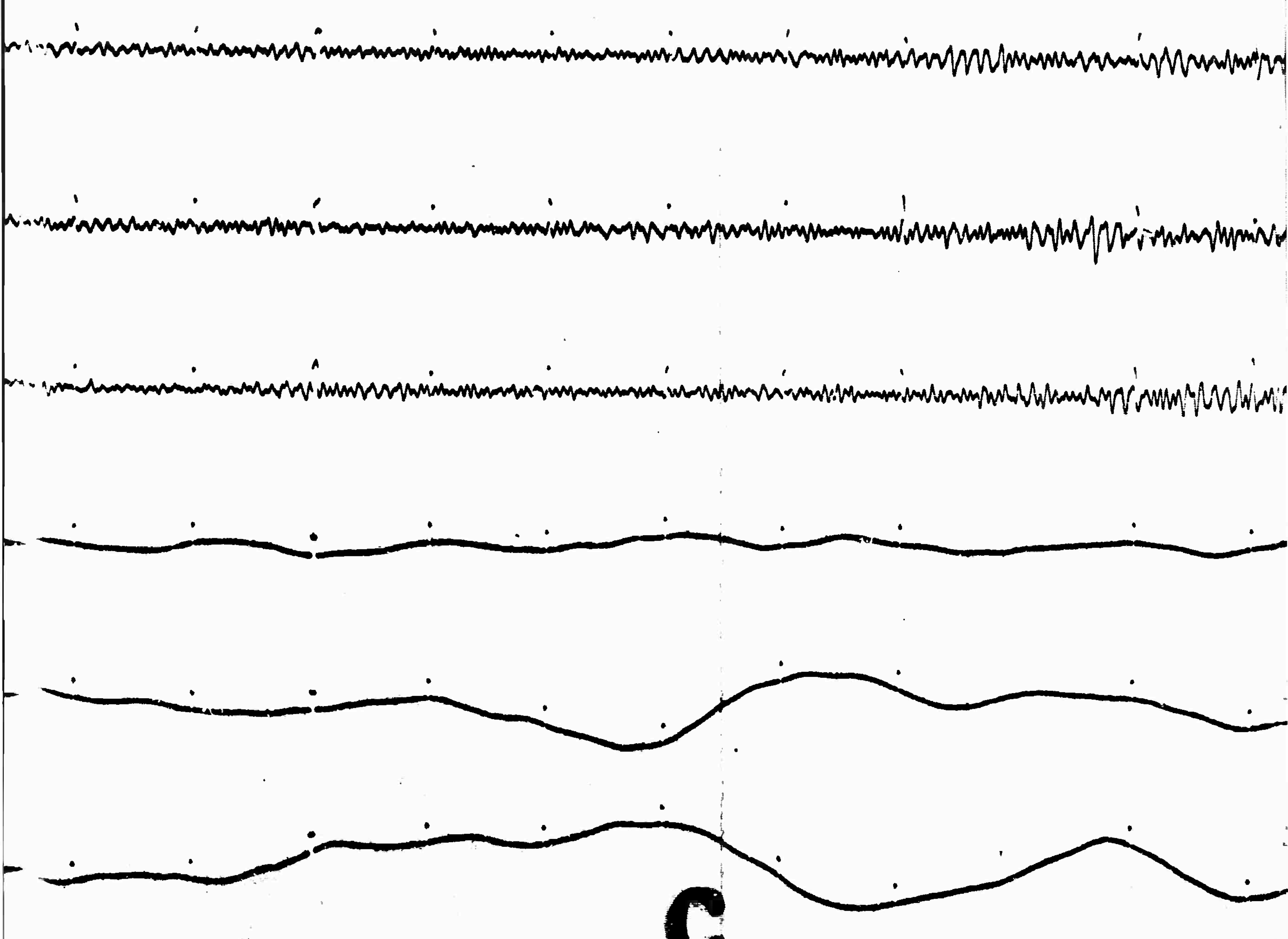

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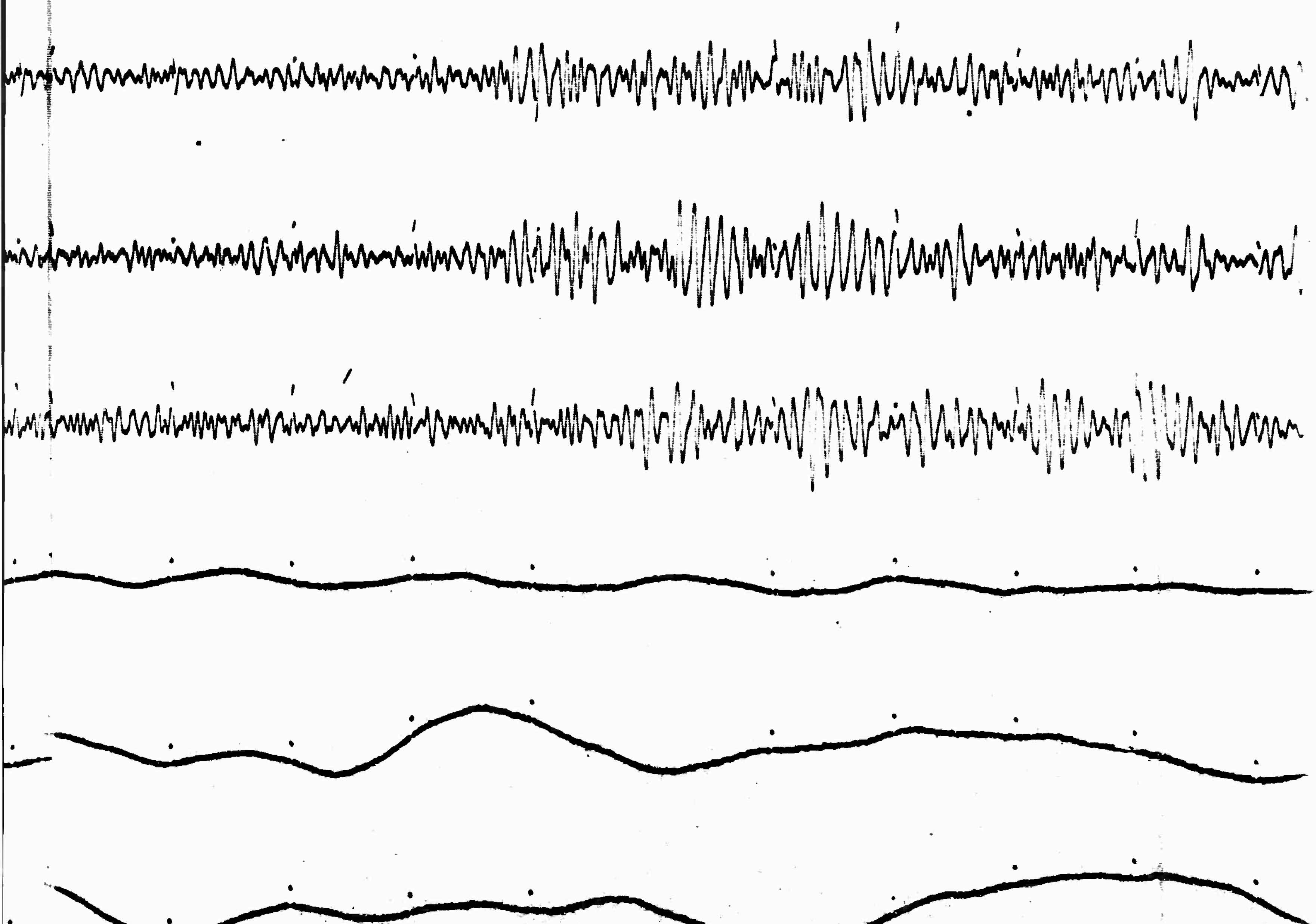

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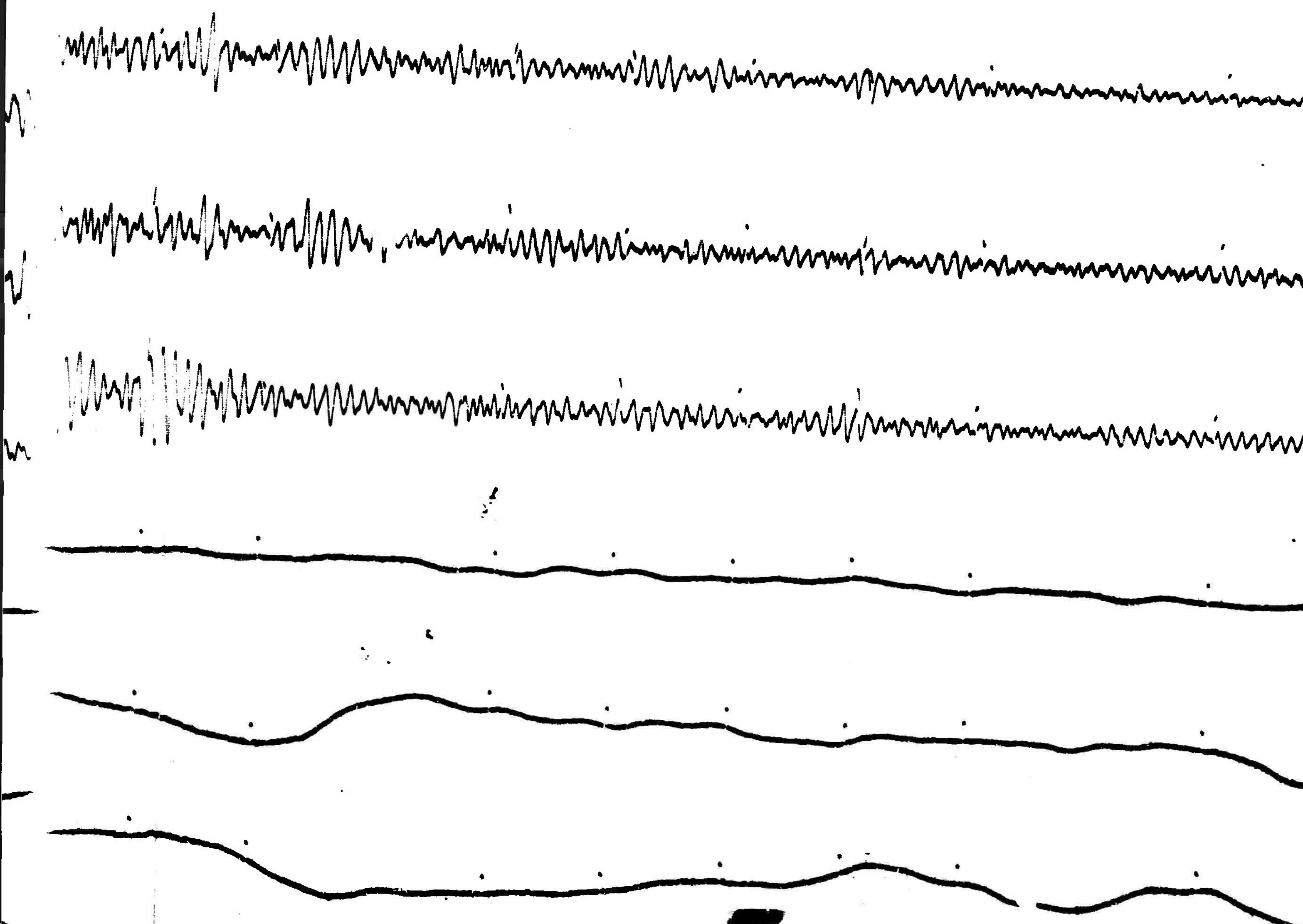

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